# North England:

## An Economic Geography

BY

L. RODWELL JONES, B.Sc.

*Cassel Lecturer in Economic Geography at the London School of Economics, University of London*

*ILLUSTRATED*

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# PREFACE

THIS book is mainly concerned with the physical environments which have influenced the evolution of some of our greatest industries.

I have attempted a more detailed analysis than space allows in general text-books of geography, and in particular it has been my aim to emphasize the dynamic factors in the Localization of Industries; to view each nucleus of production, not as something fixed or complete, but as something the requirements of which are subject to constant modification.

The site of production, as its scale, is wont to change with such modifications, and I have been as much concerned with the Migration as with the Localization of industry.

Some references to the manufacturing processes themselves have been unavoidable. They will be found non-technical in character and as few as is consistent with the general aim of the book.

I trust that this little work will be found useful and suggestive, particularly to teachers and to senior students, and so I have refrained from weighing it with those elements of Geomorphology and Climatology which are now usual in standard school text books.

I wish to thank Mr. T. Sheppard, M.Sc., F.G.S., of the Municipal Museum, Hull, for permission to use the plan of Old Hull which appears in figure 15, and also Mrs. Ormsby of the London School of Economics for reading the proofs, and for many valuable suggestions.

L. RODWELL JONES.

June 1921.

The issue of a second edition has given me the opportunity of correcting some mis-statements, and of using the latest available statistics. Comparative coal and iron output figures have been added to the appendix, and a quantitative diagram—the first I think of its kind ever produced—has been inserted in Chapter IV, to then the growing importance of our greatest concealed coal-field.

November 1923. L. R. J

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# NORTH ENGLAND

## CHAPTER I

### INTRODUCTORY

It is our aim in this book to examine the evolution of the greater industries of Northern England, and in each instance to trace the relation between development and environment.

Now, almost any division of the United Kingdom for geographical treatment will be in some sense arbitrary. In no country do we seek more vainly the self-sufficing unit. All our industrial areas are inter-dependent, and most of them are particularly influenced by conditions without the limits of these Islands. We will try to show, however, that there are some elements of unity underlying the separate areas here dealt with.

Of the great chronological periods into which geologists have grouped the surface rocks of the earth that of the Carboniferous is of special economic significance, for towards the close of it were laid down those coal-bearing strata which have provided the most productive and most valuable coal-fields of the world.* During much of this period the greater portion of England, parts of North and of South Wales, the Lowlands of Scotland, and most of Ireland, were below sea level, and were receiving deposits from the weathering of older land masses lying to the north and south of the present area of the British Isles.

The period was one of relative quiescence in which earth movements were gradual. A great thickness of rock was deposited ; first in a gradually deepening sea ; then under rapidly shallowing conditions ; and finally over large areas of swamp and lagoon, at a time when subsidence generally kept pace with deposition, but with an occasional emergence of the land. The low-lying emerged land would become temporarily clothed with a sheet of thick vegetation, the remains of which, imprisoned under the sands and muds of a further subsidence, acquired gradually the form and composition of a coal-seam.

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*Coal is not, of course, limited to rocks of Carboniferous age, e.g , in North America great reserves of sub-bituminous coal exist in Cretaceous and Tertiary formations.

The main subdivisions of the rocks of this period in England are (*a*) Lower Carboniferous or Carboniferous Limestone Series ; (*b*) Upper Carboniferous, i.e., the Millstone Grit and Coal Measures. It should be clearly understood that this major geological classification is based on the relative age of the rocks as determined by fossil remains and by stratigraphical evidence. It is not based alone on lithological character, which is altogether too variable to be the ground of any classification, save in studies of great detail. Thus, the Carboniferous Limestone is so called because in its most characteristic occurrence (e.g. in Derbyshire) it consists of a great thickness of limestone. It was here formed in rather deep water, and was succeeded by beds of calcareous shale during a shallowing period. This is so in the Southern Pennines, but if we follow the rocks of this group farther north,—e.g. into Durham and Northumberland—the limestone forms a smaller part of the total thickness, and occurs in progressively thinner beds separated by great thicknesses of sandstone and shale.

So, also, the Millstone Grit. In South

Yorkshire it is a particularly coarse grit with alternating beds of shale ; but in the Northern Pennines the texture of these grits hardly distinguishes them from the sandstones of the coal measures.

Then the coal measures themselves vary much from area to area, in the number, thickness, persistence and quality of their coal-seams ; and in the thickness of intervening beds barren of workable coal.

The whole sequence of Carboniferous rock is not always present. Thus, to take only one instance, the coal measures of South Staffordshire rest upon Pre-Carboniferous rocks ; that is to say, the Lower Carboniferous and the Millstone Grit are absent. This is because the water area of deposition was not constant—it of course extended with subsidence and contracted in periods of uplift—and the area of South Staffordshire formed part of a Midland ridge which remained above sea-level during the deposition of all but the later Carboniferous rocks.

Generally, however, we may conceive North England to have been covered with a great sheet of Carboniferous rocks in which all three subdivisions were represented ; though, as stated above, the rocks of each varied from place to place in lithological character, and also in total thickness.

Towards the close of the Carboniferous Age a series of earth movements began, which went far towards determining both the chief elements of present surface relief, and also the limits of our coal-fields. Pressure from the east folded and raised the Carboniferous strata in the great Pennine composite anticline, from which subsequent denudation has stripped the coal measures, thus separating the Lancashire and Cheshire field from that of Yorkshire, Derbyshire and Nottinghamshire. Indeed, denudation has proceeded far enough in the North and South Pennines to expose large areas of rocks of the Carboniferous Limestone series; though in the lower and middle Pennines it has not gone beyond the Millstone Grit. Similarly, east and west folds, and consequent denudation have separated the coal-field of the northern counties, Northumberland and Durham, from that of Yorkshire; and have produced the Rossendale uplift, separating the productive measures of North Lancashire from those in the south of that country.

At a later period a general subsidence

resulted in a further invasion of the sea. Rocks of Permian and Triassic age were deposited unconformably upon the eroded and inclined coal measures. They in their turn suffered emergence and denudation.

Essentially, then, Pennine England consists of an upraised mass, mainly of carboniferous rocks, upon the hollowed flanks of which portions of the uppermost carboniferous member—the coal measures—still remain. Each of these coal-fields dips away from this Pennine mass under a covering of later rock material; that is to say, for each Pennine field there are exposed and concealed areas (Fig. 1 and 1*a*).

Finally, the most recent adjustments of level, and of erosion, have left the configuration of the present coast-line such that in North England two coal-fields reach the shore, and are worked in part beneath the sea, and the remaining three are within but a few miles of tidal water.

Discussion in this work is limited to the industries of the five considerable fields* which actually flank the Pennine mass, and those of the smaller Midland fields are not dealt with. Though closely connected, in a structural sense, to the areas considered, these Midland fields, in their activities, have not the decided coastal relationships exhibited by the Pennine industries proper.

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*i e. the coal-fields of (i) Northumberland and Durham (ii) Cumberland; (iii) Yorkshire, Derby and Notts.; (iv) North Staffordshire; (v) South Lancashire.

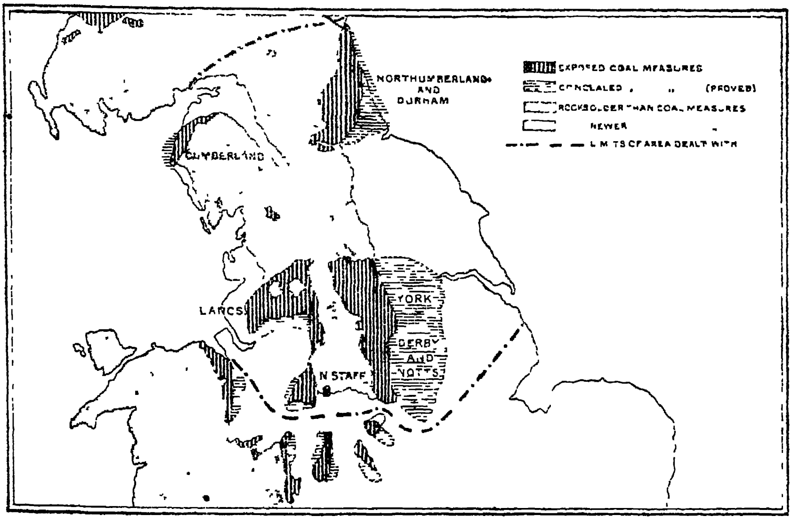
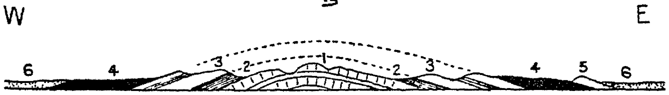


Fig 1



DIAGRAMMATIC SECTION ACROSS PENNINE ANTICLINE

1 Carboniferous Limestone
2 Limestone Shales
3 Millstone Grit with Shales
4 Coal Measures
5 Magnesian Limestone
6 Trias

Fig 1a

*General Relationships.*—A variety of geographical conditions have determined the almost unique economy whereby our land became a sort of great coastal workshop, dependent very largely upon other lands for food, for raw materials, and for markets. These conditions have been particularly effective in Northern England, which shares to the full those general advantages of world position which distinguish the British Islands.

The shallow waters which just separate us from the Continent have provided some measure of protection, but they have presented no economic barrier. Linked by Gibraltar with the Mediterranean, and through the Skager Rak with the Baltic, with an extending gulf open in the severest winter to the coasts of Norway, these " Narrow Seas " * form a part of the greatest of the world's highways. Flanking this great traffic route, pivoted between Mediterranean and Teutonic influence, set opposite the fertile plains and navigable streams of North-Western Europe, the British Isles enjoy a world position of unique opportunity. The abundant fisheries of the surrounding continental shelf became the training grounds of a sailor nation. The

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*See *Britain and the British Seas* by Sir H. J. Mackinder Chapters I-IV.

colonization of America and the opening of the Suez Canal alike provided tributary

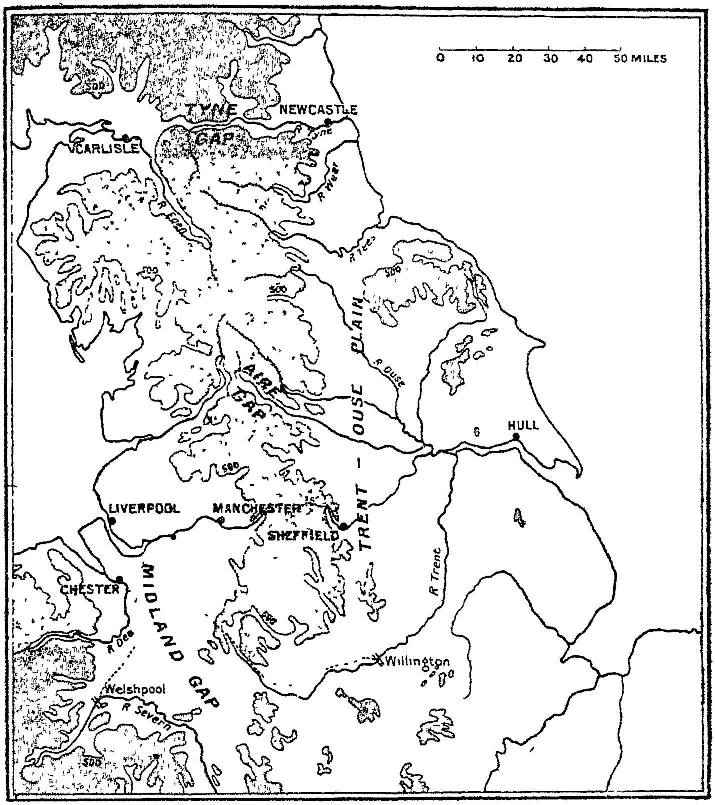

FIG 2

streams of ever-increasing traffic, and but augmented the importance derived from this position.

And then, with the coming of the era of mechanical power, but *before the days of generally effective inland transport*, we alone of the great trading communities were found with large supplies of coal available at tidal water.

Now, although these Northern industrial areas look towards the sea for so much of their activity, their development has been bound up with that of the rest of Great Britain. In this respect we should notice that no considerable barrier separates the Pennine lands from the Midlands or from Southern England. (Fig. 2). On the contrary, between the Welsh mountains and the Pennines, the broad Midland gap gives access from industrial Lancashire to the South; and, similarly, the Trent-Ouse plain ensures easy communication from the South to the industrial areas of Yorkshire, to Teesside, and to the Tyne.

From the Dee and Mersey ports of the Cheshire Plain to the nearest navigable points on the Severn and Trent there were well-established pack-horse routes, and these were replaced in their turn by the canals connecting the Mersey system with the Severn below Welshpool and with the Trent at Willington. In pre-railway days these connections with the Bristol Channel and with the Humber were of real importance.

The Pennines themselves, though high enough and with sufficient rainfall to supply the water power * which once proved so important a factor in the early textile industries, are by no means an insuperable barrier. The Valley of the South Tyne provides a route between Newcastle and Carlisle which is nowhere over 500 feet above sea-level. Much more important are the Trans-Pennine valley routes formed by the upper tributaries of the Aire, Ribble and Mersey, where the Pennines are at their lowest, and the characteristic West Riding and Lancashire industries overlap across the summit levels. Even in the Higher Pennines to the south four railways connect the Manchester and Yorkshire districts, and none has a tunnel more than three and three-quarter miles in length.

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*The water *power* is not of course of much present importance, but the high rainfall of these northern hill masses is still effective in that it now provides some of the greatest of the flanking coal-field towns with their water supply. Newcastle, Leeds, Sheffield, Derby and Manchester all derive a large part of their supply from hill reservoirs which have been engineered in narrow upland valleys, and often at great distances from the towns supplied.

# CHAPTER II

## THE NORTH-EASTERN INDUSTRIAL AREA

*Northumberland, Durham, and North Yorkshire.*—A simplified geological map of this region appears in Fig. 3. The older rocks outcrop in the west, the newer in the east and south-east, in general conformation with the Pennine uplift and subsequent denudation.

Let us note the essential economic characteristics of the major geological divisions.

(1) *Carboniferous Limestone series.*—This occupies the western and highest portion of the area. As we noticed in the introduction, the carboniferous limestone series is exposed over the greater part of the Pennine Uplands. It is a prominent member of every region with which we have to deal, but its lithological character varies essentially in different localities.

In Derbyshire these Lower Carboniferous rocks are represented by a mass of limestone some 2,000 feet thick, succeeded by shaly beds, but the conditions of deposition became so modified in Northumberland that they contain there a far greater proportion of sandstone and shale than of limestone. They contain also some workable seams of coal.*

In Durham, limestone is a more essential part of the formation, though still forming only a fraction of its total thickness. It occurs in persistent beds from a few to over 100 feet in thickness. Some of these appear at the upland surface, giving characteristic areas where the heather of the sandstone moors yields to a short grass; but others are exposed only in the deeply trenched head streams of the Wear and Tees. To the great limestone quarries of these valleys we must refer later.

(II) *Millstone Grit.*—Resting conformably upon the carboniferous limestone formation, and exposed to the east of it, comes the Millstone Grit, a mass of sandstones and shales, which is not here susceptible of clear demarcation either from the carboniferous limestone series below or from the lower coal measures above. The outcrop occupies high ground with typical moorland scenery. The sandstone grits are generally of less coarse texture than those characteristic of the formation farther to the south.

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*Very considerable reserves of coal have been proved in Northumberland to the north and west of the true coal measures. This coal is at present worked near Haltwistle, Hexham, Morpeth and Scremerston.

(III) *Coal Measures.*—These consist of sandstones, shales, and some seams of coal, twenty-one of which are over one foot in thickness and are considered workable. The average thickness of the seams actually worked is about three feet. The measures containing these seams at one time covered a much greater area. Tney have been denuded since the Pennine uplift and now occupy a basin, the northern and western limits of which are indicated in Fig. 3. Magnesian Limestone rests unconformably on the coal measures in the east and south of the basin, and, though the limit of the extension of the measures under the sea is undefined, the southern limit of the concealed measures has been proved to lie about a line from Hartlepool to a point four miles south-east of Bishop Auckland. South of this line Permian rocks rest directly on the Millstone Grit—that is to say, the coal measures were here completely denuded away before the deposition of Permian rocks. At their thickest the denuded measures are now less than two thousand feet. Intrusions of whin sill are frequent, but from the mining point of view faulting is less serious than in

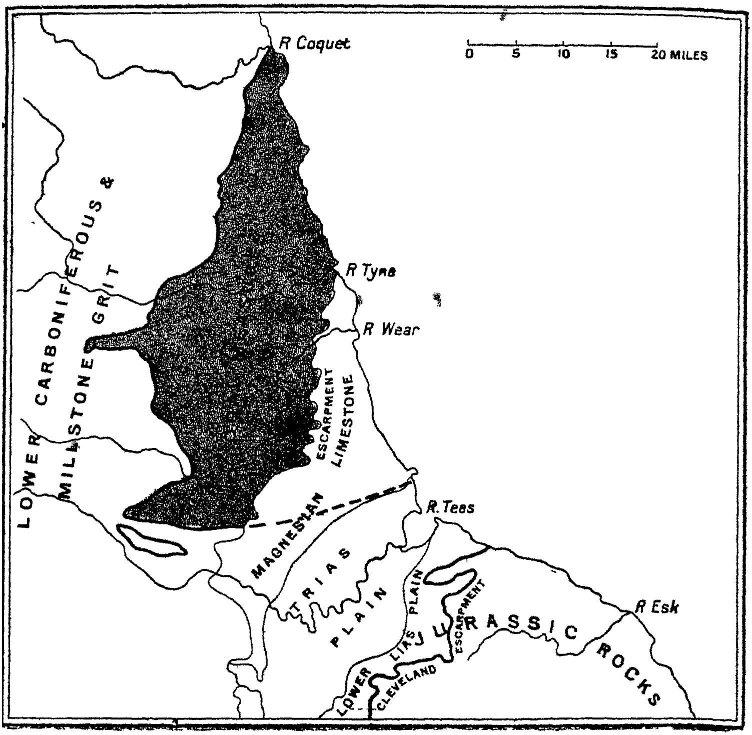

FIG. 3.—Simplified Geological Map of the North-Eastern Industrial Area, southern limit of concealed coal-field . . .

most of the British coal-fields. Moreover, the measures have been relatively little disturbed, and over large areas the inclination of seams is constant and slight. The general dip of the strata is towards the east, and as the measures have suffered extensive denudation, some valuable seams of the eastern portion of the field are absent in the west.

Almost all types of coal, except anthracite, are found in the field, and in a very general way it may be stated that the quality varies more with areal position than with present depth.

Thus, some distance north of the Tyne, the greater proportion of the production is a hard stream coal, and so the shipments from Northumberland dock* are largely of this type. The proportion of steam coal is still higher from Blythe, which is the natural point or shipment for the great Ashington group of mines. The Durham yield is more largely of gas and coking coals. This supplemental production of the two counties makes it possible for the Tyne to offer very varied qualities of coal for shipment.

For the production of iron-making coke, there is in Britain no better coal than that found in the south-western part of the field about Bishop Auckland.

*On the north bank of the Tyne.

(IV) *Magnesian Limestone.*—This formation here less belies its name than in other regions of its occurrence, for it consists mainly of a limestone with considerable, but variable, magnesium carbonate content. In some localities the limestone is almost pure calcium carbonate.* The base of the formation is formed of water-bearing sands which cover, in beds of varying thickness, the denuded surface of the coal measures. At its thickest the formation is about 800 feet, but it thins out and contains an increasing proportion of sand and marl beds to the south through Yorkshire and Nottinghamshire.

We will defer for the moment a consideration of the outcrops of the Post-Permian rocks within this region.

(V) *Glaciation and General Topography.*—The whole of the area under consideration has suffered extensive glaciation, the chief economic consequences of which are (*a*) a drift covering, very variable in thickness, of boulder clay with patches of sand and gravel, giving therefore soils not in general derived from the underlying rock structure. (*b*) The deviation of many streams from their original channels, and the filling of old channels with drift material. Thus, the River Wear from Witton-le-Wear (Fig. 4) through Durham to Chester-le-Street approximates to, but seldom coincides with, its old Pre-Glacial bed, now filled with boulder clay and later sands and clays. From Chester-le-Street the old valley, now occupied by the little River Team, shows that the Pre-Glacial Wear was tributary to the Tyne. This old valley provides the main railway approach to the Tyne from the South, while Sunderland owes its very existence to the deviation of the Wear to its present outlet. In many minor cases also, Pre-Glacial valleys have been filled up to a depth of hundreds of feet with glacial detritus, and on the coal measures this has sometimes led to mining difficulties. Coal outcrops have been masked, and the continuity of some seams interrupted by " wash-outs."

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*A matter of some importance, for it is then suitable for use as a flux in blast furnace practice.

We are concerned here chiefly with the country from the western edge of the coal measures to the sea. The greater part of the Millstone Grit and Carboniferous Limestone area is too high to support any considerable population save in the valleys of the Upper Tyne, Wear and Tees.

With regard to the influence of relief on the external relations of the area, we must note two important valley connections with the West.

(i) The Tyne gap formed by the valleys of the Lower Tyne, providing a valley rail route from Newcastle to Carlisle which nowhere exceeds 500 feet.

(ii) Between Barnard Castle (500 feet) on the Tees and Kirkby Stephen (600 feet) on the Upper Eden, the Pennine moorland is narrowed to less than twenty miles at Stainmore Pass. Railway connection across the Pennines has been made here though the summit level (1378 feet) is the greatest in England.

Terminal lines ascend the Wear to Wearhead and the Upper Tees to Middleton.

The coal measures area in Durham is dissected into two main blocks of hill country: Area 1 (Fig. 4), the roughly triangular area with Newcastle, Consett and Durham as its apices. Area 2, immediately to the south of area 1, separated from it by the River Browney and lying between that stream and the River Wear above Bishop Auckland. In both areas the summits are about 900 feet, and the main slope is from south-west to north-east, i.e., towards the Wear and Tyne valleys.

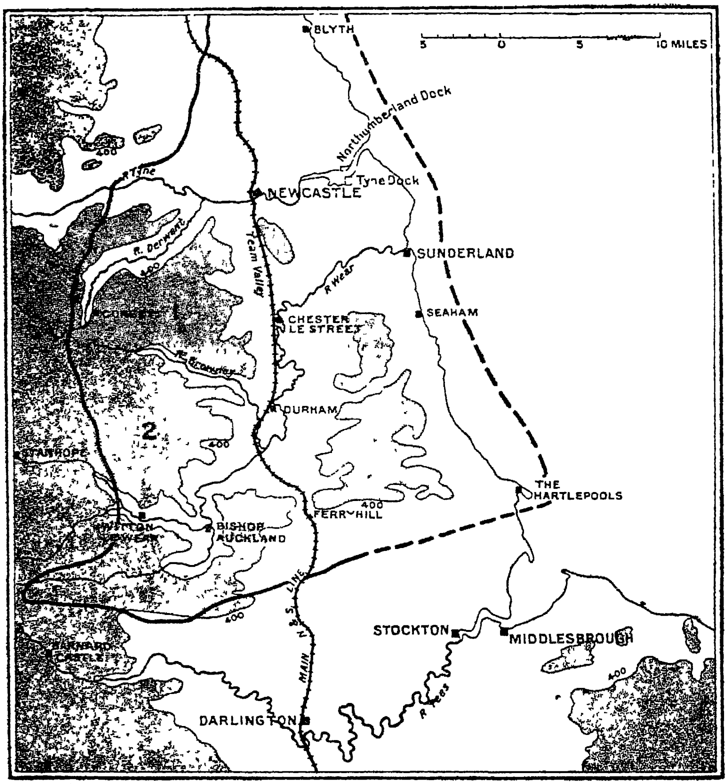

FIG. 4.—General Relief of the North-Eastern Industrial Area
The heavy black line includes the coal-working area south of Blyth save for a few scattered collieries working the carboniferous limestone coal in Northumberland.

East of the Wear the country rises gradually for an average distance of about three miles.

and then suddenly, at the very irregular escarpment of the Magnesian Limestone. Opposite Bishop Auckland this formation is at its maximum height of 630 feet. It everywhere slopes gradually to the coast, near which it is intersected by a number of deep, narrow and wooded denes.

The main North and South rail route is provided by the Team valley from Newcastle to Chester-le-Street, and by that of the Wear from Chester-le-Street to Durham. At Durham the main line leaves the Wear valley to seek a directer route to Darlington through the limestone gorge of Ferryhill. Crossing the Tees, the line enters the Ouse plain of Yorkshire, and this most obvious and most important southern outlet of the district is the one also of least topographical difficulty.

*The Coal Industry.*—There is in London a street once designated Sacole (i.e., Sea-Coal) Lane,* and one may take the fact as an indication of the industry characteristic of the north-eastern coal-field. The constant succession of steam colliers now running from Blyth, from the Tyne, from Sunderland and from Seaham to London are carrying on a traffic movement which has been in existence certainly for seven centuries. For the last two centuries the shipment has been much less exclusively to London; but the point to notice at once is that no other British coalfield has so important an historical connection with the shipment of coal. It is not merely a question of the priority of such shipments, but of the relatively great quantities continuously sent.

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* There appears to be some doubt as to the origin of the term Sea-Coal Coal was quarried from the cliff-side in Northumberland, and it is frequently washed up on the beach in that country and in Durham It is quite probable, however, that the term is derived from the fact that until the days of railways most coal used in the South of England was brought in by sea.

To understand this we must try to realise a little what were the practical limitations to coal-mining before the days of the steam engine, and so see what possibilities this region offered to the early industry. We must realise that by far the greater proportion of the coal raised to-day was absolutely inaccessible to the early miner; for the depth of his working was definitely limited by his inability to deal with (i) water, which flooded his shaft in the making or his workings in their development; (ii) gas, against which, before the use of the Davy lamp, and modern power methods of ventilation, he had no efficient safeguard.

Before the eighteenth century then, coal-mining was limited to outcrops, or to seams at very shallow depths.

Again, though coal began to be used domestically in the fourteenth century, and was used even at an earlier date for lime burning, yet before the general use of coal for steam raising, and of coke for iron smelting, it was not in sufficient demand to pay for land carriage in times when good roads were not.

The influence of these conditions is definitely expressed in the situation of the early collieries.

For many centuries (indeed, till the railway era) all considerable workings were within a very few miles of the navigable portions of the Tyne and Wear rivers. Coal in the south-east (under the Magnesian Limestone) was too deep, and in the south-west, too far from sea or river, for possible working. Thus the early development of the field was bound up with the history of transport on, and to, the rivers Tyne and Wear.

These rivers cut into the field at its broadest. The Tyne (apart from modern improvement) was navigable on the tide for small sea-going vessels up to the old bridge at Newcastle, and for keels to about Newburn.

The Wear was navigable to about one mile only for sea-going vessels, but keels could reach the little hamlet of Fatfield (see Fig. 5).

Some seams, not always the best, the thickest, or those now worked, were shallow enough for the early workings we are now concerned with. Some of the upper seams outcrop in the intersecting valleys which divide this coal-field into rough blocks of undulating country. Some seams again appear on the Northumberland coast. These shallow and outcropping seams were early worked; first in outcrop, then in bell pit, and later by shallow shaft with adit drainage to the valley side.

From these rudimentary mines to the nearest navigable (for keels) point on the Tyne or Wear the coal was taken in baskets by great trains of pack-horses; and thence by keel men to the 100 ton wooden coal vessels on the lower river, and so to London or abroad. Even, in spite of the tiny distance concerned, this movement to sea navigation bulked largely in the final cost in London.

As an example of the extent of the traffic long before the possibility of deep mining, we may note that in 1615, 400 vessels (exclusive of keels) were engaged in shipment from the

Tyne alone. Newcastle shipment trebled in the eighteenth century. In 1820, 1,860,000 tons were shipped from the Tyne* and about half that quantity from Sunderland.

Thus, the industry here early acquired a momentum sufficient to attract to its use such scientific resources as became available. Chief among these was Newcomen's " atmospheric " pumping engine, which was in general use in the coal-field by 1750.

Before this, the main obstruction to development was water trouble, which set a limit to mining below a natural drainage level. Water wheels were better adapted to the continuous motion involved in raising the coal in the shaft, but obviously a water-head could not be usually available. In a few instances at this period the water-wheel for the shaft was turned by water itself raised from the mine by a Newcomen engine. More generally, before the use of reciprocating engines, a horse winch was used for raising the coal.

Then the heavy soils made even the few miles from mine to river-side an arduous business, whether for pack-horse or wagon.

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* *A view of the County of Northumberland*, Mackenzie, 1825.

Rough wooden tracks were used, then wooden rails, then flanged wheels and cast-iron rails. The Lower Tyne and Wear saw the whole evolution of rail-roads long before the use of locomotives.

Again, the relief is such that many of the mines were several hundred feet above sea-level. There was considerable gradient to water-side, though in some instances intermediate block-like uplands had to be crossed. The topography generally favoured the use of self-acting inclines, in which loaded trucks in descent pulled up the empties from the valley levels.

These inventions and developments, then, made mining possible in deeper pits and over a wider area, though still the main workings were seldom more than ten miles from Tyne or Wear. With the use of rail-tracks for the horse-drawn wagons some extension in the distances covered became possible, and a tendency grew up to direct the rails to shipping points nearer the river mouths, where was enough water for sea-going ships without intervention of keels. Thus were saved the expenses of keel traffic and of trans-shipment.

And here we may notice a peculiarity in the section of the Lower Tyne and Wear, which made usual the method of shipment by staiths, still characteristic of the north-eastern coal-field. The lower Tyne from Newcastle to the sea is almost of the nature of a shallow gorge, though the steeply-sloping banks leave a narrow ledge of land on either side the water-level.

Advantage was taken of this conformation by extending, as it were, this high bank by means of a wooden structure (or staith) right up to and a little beyond the water's edge, so that the coal wagon could be run into a position directly over the vessel to be loaded. A similar but less regular topography enables the same method to be used at the mouth of the river Wear. Naturally, enough, the first staith building was resented by the keelmen, and several unsuccessful attempts were made forcibly to prevent the use of them.*

Thus began the direct movement of coal from colliery to sea-going vessel.

Three main causes stand out as accounting for the extension of the area of coal working in the nineteenth century.

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* See *A Series of Views with Descriptive Sketches of Northumberland and Durham Collieries*, by Hair and Ross, 1844, p. 41. These views give an excellent idea of the general surroundings of a colliery in the early nineteenth century.

*Firstly*, the coal of the southern or Bishop Auckland district became available for shipment after the opening of the Stockton and Darlington Railway in 1825. Previously coal had actually been shipped from Tyneside to the Tees, a comment both on the difficulties of inland transport in pre-railway days and on the late development of the South Durham field.

The line was expressly built for this purpose. It was in a few years continued to Middlesbrough, and to Hartlepool. South Durham coal was soon being shipped from all these points on the Tees.

*Secondly*, as we shall see, the development of the Cleveland iron industry was dependent upon South Durham coking coal.

*Thirdly*, modern mining practice, and especially modern methods of shaft-sinking through water-bearing strata, have made possible the deep mines sunk through the magnesian limestone and its basal quicksands into the coal measures below. Thus large collieries have now been developed in the extreme east and south-east of the coal-field.

No other coal-field, not excepting those of South Wales and of the Firth of Forth, has had to such an extent the combined advantages of mining accessibility, of good quality coals, nearness to tidal waters, and position with regard to coast-wise shipment and near Continental markets.

It will be convenient at this point to indicate the nature of the modern outlets for coal shipments—noting them in order from North to South.

*Blyth.* (Fig. 4).—On the little river of that name, is almost a creation of the N.-E. Railway Company, which has deepened the river entrance to 30 feet L.W.O.S.T., and built shipment staiths which connect with the great Ashington group of collieries.

Coal was mined near the coast here in very early times and shipped from the little village of Blyth, but its present importance is entirely bound up with the harbour improvements and the development of large-scale modern collieries in the neighbourhood. The shipment is largely of hard steam coal.

*The Tyne.**—The limit of effective navigation on the Tyne stands where it did centuries ago when coal shipment first became the main traffic of this stream. The map of the old wagon-ways (Fig. 5) shows us that coal was not shipped from points farther up the stream than Newburn. The same place is the limit of the modern deepening.

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* For a full account of the Geography of Tyneside see *Journal of Royal Geographical Society*, Nov., 1912: "The Tyne," by Prof. A. J. Sargent.

We see in the case of the Tyne three very typical stages of river development.

*First* we have the river navigable for the sea-going vessel of early times right up to Newcastle. Here, was, in any case, the natural limit of such navigation, though the stream was available to Newburn for coal keels. The low arches of the old bridge (long since destroyed) entirely precluded farther entrance for masted vessels, even had a sufficient depth been available. With increasing size of carriers the tendency was for keels to load to vessels farther and farther down the river.

*Secondly.*—The increasing use of the wagon-ways leading to the staiths on the lower river, especially about the neighbourhood of the present Tyne Dock and Northumberland Dock (Fig. 4), and the shipment to sea-going vessels here without the intervention of keel.

*Thirdly.*—The modern improvement of the river, making it available for small steamers to Newburn (Fig. 5), and whereby big colliers are loaded at Dunston staiths, and great war vessels launched at Elswick.

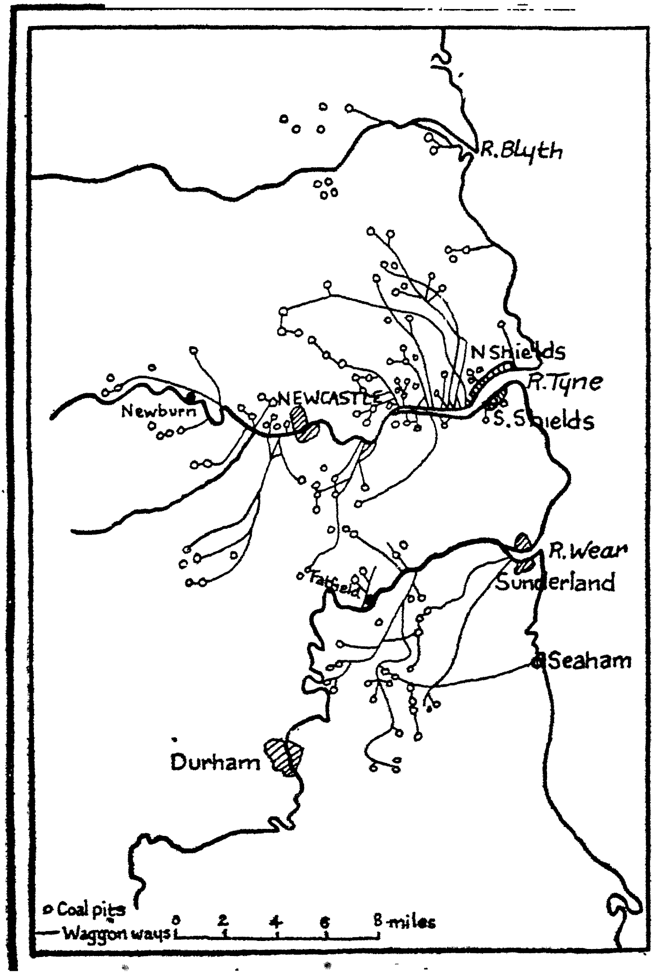

FIG. 5.—Map showing Collieries and Wagon-ways worked at the beginning of the nineteenth century (from a plan in the British Museum).

There was obvious strategic value in the position of Newcastle itself, for here we reach the first commanding hill site as we sail from the river mouth (Fig. 6). Here, too, between the hill masses of Newcastle and Gateshead the river suffers some constriction, and was more easily bridged than at points immediately above or below. The fortress site, the crossing place of the Roman road, the early bridge, the limitation of sea-going navigation, all gave particular importance to this place, and, with the coming of the railways, the concentration of valley routes (e.g. Team valley, Derwent valley and Upper Tyne) have added to its importance.

However, to-day Newcastle is chiefly the business capital of an industrial area ; an area curiously limited by the nature of the topography which characterises the lower river. Throughout almost the whole of its improved length the normal section across the Tyne exhibits two narrow strips of land on either side at about the water-level, and beyond each a short but precipitous slope to higher ground.

It is these riverside strips which constitute the real manufacturing area of Tyneside. Here, in two long parallel rows, are the ship-building yards, the engineering shops, the steel works, and the coal staiths characteristic of the river.

The greatest present coal shipment takes place near what were the termini of the later wagon-ways, i.e., at the Northumberland and Tyne docks on opposite sides of the river, and two miles only from the sea (Fig. 4, p. 20). These are the only docks of the river, a great deal of the traffic of which is direct from wharf-side. They deal chiefly with coal shipment, and the natural return freight of Baltic pit-prop timber.

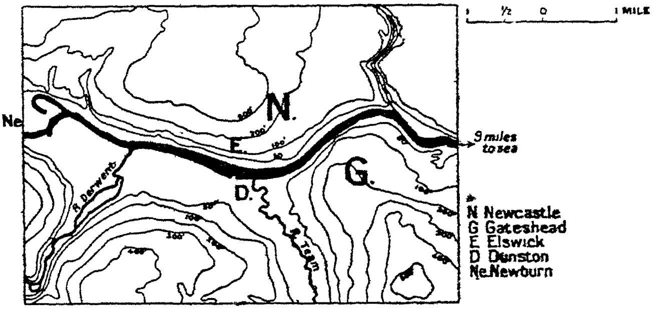

Fig. 6

Between Jarrow and South Shields the precipitous south bank gives way to an area of partially reclaimed marshy land—Jarrow Slake. It is from the eastern extremity of the slake that Tyne docks and its timber ponds were engineered. The slake must at one time have been more extensive, as it has been partially filled by being made the dumping ground for the sand ballast of returning colliers. The only other point of very heavy coal shipment is at the staiths at Dunston. Near to these is an example of the modern concentration of flour milling at our chief ports in the great mills of the Co-operative Society.

For the last miles of its course the Tyne changes sharply its direction to the north-east and cuts a narrow and deep valley between the old towns of Tynemouth and South Shields.

Finally, we must note that the deep dredging of the Tyne, which has made this little stream available for the largest vessels a dozen miles inland, would be of no avail if the flow of the tide were not concentrated at the entrance by two long breakwaters, reaching nearly a mile out to sea.

Just within the northern one lies the old town of North Shields, where modern facilities and an immediate market have ensured the development of the old fishing industry.

*The Wear.*—Improvement was more difficult here than in the case of the Tyne. In the first place, the Wear is narrower; and when in modern times a continuation of its activities was only possible by means of engineering improvement, it was found much less easy to deepen than the Tyne. A great deal of the Tyne deepening was through Glacial Clay, and only at a few points was blasting of the old rock Pre-Glacial channel necessary. The Wear, directed to its present outlet in Glacial times has cut a deep rock channel through the Magnesian Limestone, and here any deepening had to be through quite hard rock. Rock dredging with specially constructed dredgers has rendered the channel available for the big vessels of modern commerce for about one and a half miles above the mouth; but the expense of operations and the narrowness of the stream placed a limit to further works.

The traffic of this river then, unlike that of the Tyne, is confined to its last two miles only. Ship-yards and engineering works are crowded into the narrow bank on this short stretch, but the greater proportion of coal shipment now takes place from staiths in Sunderland Docks, which are built outside the river, but in artificial connection with it.

*Seaham*—like Blyth, owes its modern importance to an almost entirely artificial harbour, and was improved to serve particularly the East Durham collieries. Its use is confined to coal shipment.

Coal is shipped in large quantities also from Hartlepool, but we will reserve any account of the place for the next section, and include it now only for the sake of completeness in the table of coal shipments.

So that in the year before the great war this one coal-field was responsible for about one third of coast-wise and foreign shipments. Germany, France, Italy and Russia took the greater part of the export. In 1922 the export had assumed pre-war dimensions, the diminution in the case of Russia being made good by large increases to Belgium and Holland.

Table of Coal Shipment for the North-East District in millions of tons.

| | 1913 | | 1919 | 1922 |
|---|---|---|---|---|
| Shipment from: | Coastwise | Foreign | Foreign | Foreign |
| Amble | .09 | .48 | 2. | 22.6 |
| Blyth | .36 | 3.97 | | |
| The Tyne | 4.28 | 13.32 | 7.8 | Coastwise |
| Sunderland | 1.34 | 3.01 | 1.7 | |
| Seaham | .94 | .97 | | 6.9 |
| W. Hartlepool | .47 | 1.25 | .5 | |
| Northumberland and Durham. | 7.48 | 23.00 | 10.2 | 29.5 |
| United Kingdom | 20.45 | 73.40 | 35.25 | 78.8 |

## THE TEES AND THE CLEVELAND ESTUARY HILLS

Referring to Fig. 3, (p. 15) we see that the main structural divisions here are :—

(I) *Triassic Plain of the Lower Tees.*—In this area the magnesian limestone is covered by a series of red sandstone and clayey beds, soft rocks now worn down to the plain surrounding the Tees estuary. At the base of these formations are the beds of rock salt (one of them attains a thickness of 100 feet), which supply the Tees salt industry and the Tyne alkali works.

The thickness and depth of these salt beds increase with their dip towards the Tees, and thus the bore-hole workings are mainly limited to a few miles just north of the estuary where the beds are thick enough, yet not too deep, for economic working.

(II) *Jurassic Rocks.*—An alternation of sandstone, shales, limestone and clays. The Lias (Lower, Middle and Upper) forms the lower portion of these rocks. These are mainly shaly in character, though the Middle Lias (the thinnest of the three) contains much sandstone and the very important ironstone seams of the Cleveland area.

The upper portions of the Jurassic group (i.e. the oolite), consist mainly of calcareous grits and impure limestones, and the denudation of some of these harder beds, resting immediately above the softer shale of the Lias, has led to the great escarpment which characterises the Cleveland area.

Topographically the chief features are (Fig. 7):

(i) The Tees plain extending a few miles on either side of the funnel-shaped estuary. To the north of the estuary the plain is developed wholly upon Triassic beds, but to the south-east, the soft Lower Lias, the lowest of the Jurassic rocks, forms a part of the plain.

(ii) The detached hill masses of Eston and Upleatham, capped by hard rocks of the lower oolite, and in the scarped edges of which the Middle Lias and its main ironstone outcrop. Eston and Upleatham were the earliest, most accessible and most productive of the Cleveland mines proper. The seam here was over 12 feet

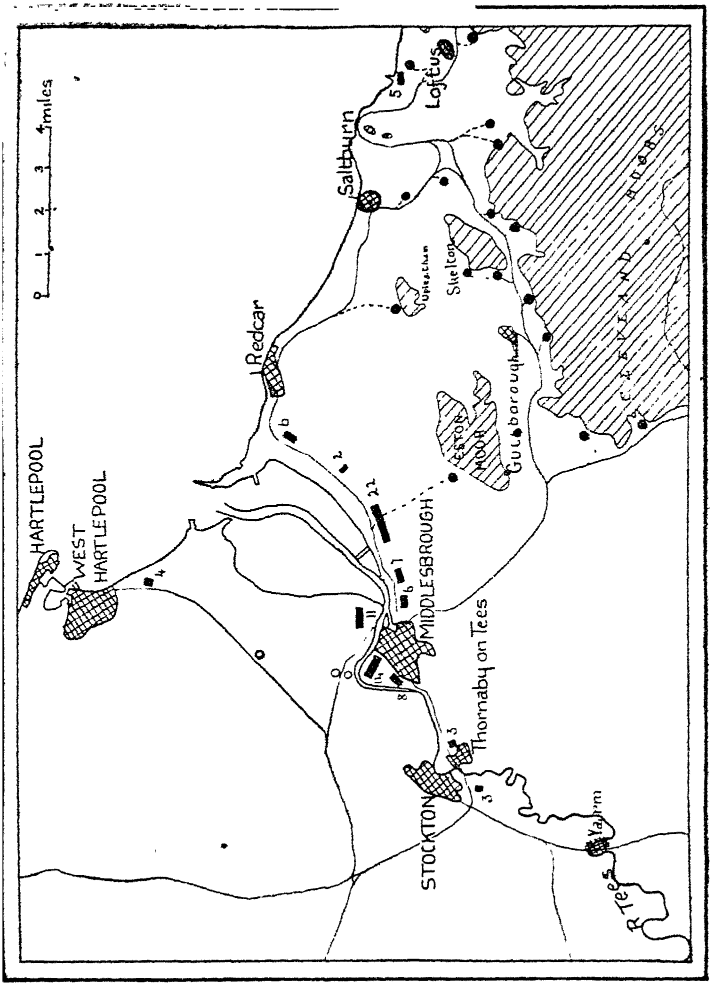

FIG. 7.—Map of the Cleveland Industrial District.
Iron Mines ●; Land over 400′ \\\\; Railway ——; Group of Blast Furnaces ▬ 7 Showing number of Furnaces; Chief Salt Works o

in thickness and with little intermixture of deleterious matter.

(iii) The main escarpment running east and west just to the south of Guisborough valley.

As to the external relationship of the Cleveland area, we should notice that no difficulty stood in the way of rail construction connecting the Eston, Upleatham and Guisborough valley iron mines with the estuary. Further, the Tees plain itself is practically continued into that of the Ouse.

*The North-Eastern Iron and Steel Industry.*—Geographical control is more apparent in the localisation of the Iron and Steel industry than in the case of any other, and it will be advisable for us to consider what have been and what are the essential requirements of the industry.

At the time of the Roman occupation and throughout recorded history in Britain, methods of obtaining iron from its ores have been known and practised. The essentials were supplies of ore and of wood ; and, quite early in the history of the work, a head of water to work the blast and the forge hammers. Thus any hilly, forested area, where rocks containing a considerable percentage of iron were easily accessible, might develop an iron industry. As iron ores are among the most widely distributed of minerals, there were many such districts, and before the use of coal in iron smelting the industry was widely scattered.

Even before the use of coal for the actual smelting of iron, there grew up a tendency for some localisation of the industry on coal-fields, for (i) coal was early used in the finishing and forging of iron ; (ii) the coal measures themselves became (for a period only) the source of our main supply of ore.* In this case the ore was usually contained in nodules in thin seams often worked from the same mine as the coal. In some cases, and this was particularly important when coal was used in smelting, the coal and ore were present in one and the same black-band seam, as in North Staffordshire, and in Lanarkshire. Now we may notice at once that with regard to the coal measures source of supply, the north-eastern coal-field was below average of British coal-fields, and had not the accessible resources of Staffordshire, Shropshire, South Wales and Lanarkshire.

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* See Appendix.

Though the North-Eastern district exhibits all phases of the normal development and localisation of the industry, it is only since the latter half of the nineteenth century that iron production has been pre-eminent, for it was only then that large quantities of ore became available. From the earliest times down to the middle of the eighteenth century, when Darby's improvement of Dudley's inventions made the smelting of iron by coal practicable the industry was certainly very scattered, and traces of early iron-work—old forges, bloomeries and scoriae heaps—occur in many places. From the seventeenth century the Derwent valley was a particularly important seat of the industry and coal measures ore was used. In the first half of the nineteenth century coal was generally used for smelting, and the chief blast furnaces of the area were located as follows :—

(i) At Redesdale and Hareshaw on the Carboniferous Limestone there was worked a local supply of good quality ore ; but these places lie in the North Tyne valley, about a dozen miles to the north of Hexham, and therefore at a considerably greater distance from the navigable Tyne and the coal-field. Furnaces here worked intermittently for a few years.

(ii) Birtley and Wylam on the Tyne and Shotley on the Derwent (these were on the coal-field) had originally coal measure ore, and had the advantage of nearness to the river. Their difficulty was a sufficient and cheap supply of ore.

The total production of pig-iron from these little furnace groups of the early nineteenth century was in no way comparable to that of the Midland and South Wales coal-fields of the same period. However this lack of ore and proximity to tidal water resulted in the first use of the Cleveland stone outside the Esk (Whitby) valley.

The Cleveland iron seams of the Middle Lias outcrop not only in the Esk valley, but also on the coast e.g. at Robin Hood's Bay, at Staithes and at Kettleness. It was gathered from the fore-shore, quarried from the cliff-side, and (after the opening of the Grosmont-Whitby railway) railed from Eskdale to Whitby, and so by ship to Tyneside, when it became known as Whitby stone. Upon this supply the Tyneside and Derwent furnaces depended for some years, though some Cumberland and foreign ores were also used.

Hopes were still entertained that coal measures ore in other and untried areas might be sufficiently accessible for economic use.

It was in this belief that some prominent iron-masters opened three blast furnaces at Witton Park (Fig. 4) in the south of the coalfield. These were to supply iron for their newly erected rolling mills near Middlesbrough, to which site prolongation of the Stockton and Darlington railway, and waterside facilities, gave special value.

They were disappointed, and for some years supplied these Witton Park furnaces with Whitby stone, though, if they had but realised it, the same seam which out-cropped on the coast was available within two miles of their wharves at Middlesbrough. Also it was there thicker, more accessible, and of considerably higher grade.

Then in 1850 the main ironstone seam was discovered in Cleveland proper, that is to say, in the north-facing escarpment, which overlooks the Tees estuary. It was first worked in the sides of the isolated hill mass of Eston moor, and then in the similar detached Upleatham hill (Fig. 8).

These new workings were just in time to supply the enormous demands made on ironwork for rail-making and ship-building. Just in time, in fact, to give continuity to the representative industries of the area.

In ten years the Cleveland production of iron ore exceeded that of any other British source of supply. The inland and some of the Tyneside furnaces were unable to stand the competition, and in a few years by far the heaviest part of the enormously increased production of this district was from new Teesside furnaces. By 1880 the production of Cleveland stone was over five million tons (i.e. more than the 1920 production).

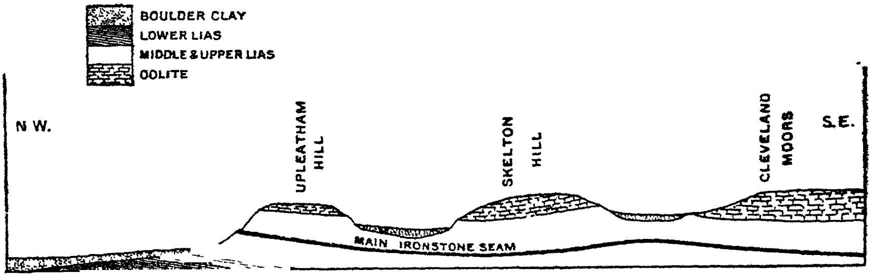

FIG. 8.—Diagrammatic section NW. and SE. through Upleatham Hill. Vertical scale is six times horizontal.

A group of blast furnaces indicates the site for the assemblage of the main three heavy raw materials required by the industry; that is to say, of coke (or of coal to be coked), of iron ore, and of a quantity of limestone which helps to form the flux. In modern practice, about half a ton of coke is required for each ton of Cleveland stone smelted; the ironstone is calcined before use, and the requirements of limestone for Cleveland stone are comparatively slight, though, as we shall see, so much imported ore is now used that the actual movement of limestone to the area is very heavy.

We see then that the smelting of some five million tons of Cleveland stone required the assemblage of immense quantities of the other two main raw materials.

The outstanding advantages of Teesside are (Fig. 7):—

(*a*) A very short lead (about an average of eleven miles now) from iron mine to estuary-side furnace. Originally, this was very much less, for the greatest and earliest of mines was Eston, and this was within a mile or so of the first furnace. On the other hand we must note that the general exploitation of the ore has been to the south-east, i.e. away from the escarpment. The most accessible ore, which was also that of the highest grade, has been already worked out. The main seam splits up and the ore itself becomes more expensive to mine and to clean as the mining area extends to the south.

(*b*) The south-western portion of the Durham coal-field yields a particularly good class of coking coal. The coke is hard, compact yet porous, non-clogging in the furnace, and low in sulphur and silicon content. This coal has seldom to be brought more than twenty-five miles.

(*c*) Limestone for flux is available at exposed beds in the Carboniferous Limestone in Upper Weardale, about Stanhope and Frostley (Fig. 4). Another source of supply is the Magnesian Limestone escarpment, wherein beds of nearly pure limestone sometimes occur. It is extensively quarried about Ferryhill gorge, near Sunderland, and at Barton and Forcett near Darlington. The magnesian limestone proper (i.e. with considerable magnesium content) is quarried also at Raisby Hill to provide the linings for basic steel furnaces.

(*d*) Situation on estuary side, and therefore readily accessible for foreign ore for mixing (or for plants only using these ores); and for the shipment of iron and steel goods.

Such were the natural advantages of the Teesside sites that many of the older inland works quickly collapsed.

The use of iron for ship-building gave the industry an adjacent market for ships' angles and plates. The latter half of the nineteenth century witnessed a great increase in foreign and colonial railway construction, and the exports of rail and bridge work from Teesside were soon the most considerable in Europe.

Further, in the mid-nineteenth century came an invention in the iron and steel industry comparable to the introduction of, say, the power loom, in the textile industries. Before the general introduction of the Bessemer and Open Hearth steel processes, pig-iron, the semi-raw product of blast furnaces, was either made into cast-iron for foundry work, or into malleable iron by the slow and laborious process of the puddling furnace. The mild steel produced so economically in the new processes could be used, and with advantage, for practically all the purposes for which the puddled iron was previously employed, and at a lower cost.

However, the original Bessemer and Open Hearth processes could not be employed with pig-iron containing phosphorus, for this element was not removed in these processes, and the resulting steel was of poor quality. As phosphorus cannot be removed in the blast furnaces either, it follows that only non-phosphoric ores could be used in these new methods of large-scale production.

Now, Cleveland ore contains phosphorus, and the rapid replacement of iron puddling by the new steel processes had these two results in this district :—

(i) The development of an increasing import of foreign (Spanish and Swedish mainly) non-phosphoric, high-grade ores, and the increase of coastal plants using only foreign ores.

(2) The movement of Cleveland pig-iron to other parts of Great Britain, chiefly for forge and foundry work and not for steel making.

It is many years since the Gilchrist Thomas inventions rendered phosphoric ores available for steel making by both Bessemer and Open Hearth processes, but the lapse of years between the first use of these processes at all, and the use of the basic variations of them, was sufficient to give a certain amount of momentum to the work depending upon foreign non-phosphoric ores. Some blast furnaces on the Tyne, at Jarrow, at Seaton Carew, near Hartlepool, and in the Middlesbrough area itself, are entirely dependent upon foreign ores. During the war the difficulties which were feared, and which were to some extent realised, in the importing of foreign ore led to an increase in the use of basic-steel plant in this and other iron-making districts.*

Fig. 7 (p. 39), shows the present location of the blast-furnace groups concentrated around Teesside. In addition to the furnaces shown, there are groups at Consett (12) and at Jarrow (4).

In recent years the North-Eastern district has produced about one-third of the British pig-iron output, and about one-third of the ore used, too, is from abroad.

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* *Iron and Steel Industry* 1914-18, by F H. Hatch, Chap VII

We have noticed that the Cleveland iron and steel industry is absolutely dependent upon the supply of South Durham coking coal. The coal is usually coked before transit to Teesside, and at very many of the Durham collieries one may see rows of the old Beehive coking ovens, and, in more recent years, of modern bye-product ovens. In the former, a portion of the coal is burnt to raise the temperature of the remainder sufficiently to reduce it to coke. The volatile products are wasted. In the latter, the coal is heated in closed retorts. The coal-tar, benzol and ammonia (absorbed with sulphuric acid to make the ammonium-sulphate fertiliser) are recovered, and part of the gas is ignited to carry on the distillation. Even so, more gas is evolved than is required for this purpose, and the surplus may be used as a source of power, either by burning to raise steam in a turbine dynamo plant, or in gas engines.

However, the bye-product oven did not win its way immediately. Capital expenditure was very heavy, the plant complex, and the designs under constant improvement. The coke produced at first compared unfavourably with the Beehive product in hardness and general appearance. For long, iron-masters were prejudiced against its use.

Now, with the best modern practice we may state of bye-product ovens in comparison with the Beehive type that :—

(*a*) With the best coking coal they produce a metallurgical coke equal to that of the Beehive oven.
(*b*) They produce a useful coke from coal of such a quality that it could not be used in the Beehive oven.
(*c*) Very valuable bye-products are recovered.
(*d*) A surplus of power is available at every coking installation.
(*e*) They produce *more* coke from an equal weight of coal.

Here, as in America, the special need of the bye-products for munitions in war time has entailed a particularly rapid increase in bye-product plants. The Beehive oven will soon be obsolete. At the present time; these deal only with about a quarter of the metallurgical coke made in the United Kingdom.

Having regard to the distribution of works we must notice that the pig-iron of the blast furnace, the ingots and billets of the steel works, the finished plates, angles and rails of the rolling mills, are all articles of commerce. Some pig-iron is exported, some sent coastwise from the district. Very great quantities go to the Sheffield, Midland and Scotch iron works.

To the same districts great quantities of steel ingots are sent. A surplus of ships' plates and angles finds its way to other shipbuilding districts.

But the fact remains that the greater part of the steel made is used for ships' plates and angles, rails, steel tubes and bridge work ; in fact for large-scale, standard steel work which is required within the area, or which is exported from the Tees or Tyne. This being so, the greatest economies could be effected by the juxtaposition of coking ovens, blast furnaces, steel works, rolling mills and shipyards. In such cases the pig-iron could be taken molten to the steel furnaces ; surplus blast-furnace gas would be used to heat the coke-ovens ; the richer coke-oven gas (after abstraction of liquid bye-products) would provide all the fuel necessary for steel making and the power required for rolling mills and steel finishing generally. In fact, no more fuel would be necessary for converting the ore into the finished steel product than that inserted in the coking oven to produce the necessary amount of coke for smelting, and surplus power would still be available.*

Such complete unification of plant is not seen even on the north-east coast, with its typically heavy steel industry, but there has been a tendency in this direction, and in many cases steel works and rolling mills adjoin the blast furnaces; but the capital expenditure on new plant necessary to effect the greatest working economies has not been undertaken.

*The Tees Ports—Yarm, Stockton, Middlesbrough and the Hartlepools.*—The Tees estuary (Fig. 7) is funnel-shaped and partly enclosed by a sand spit called Seaton Snook. In its unimproved state there were, at low tide, only a few feet of water on the bar at the mouth of the estuary. Great mud banks were exposed at low water and winding irregularly through these was a very shallow shifting channel. It was often necessary to change the position of the buoys which lit the channel at night, and the navigation conditions generally were such as seriously to hinder the development of the old town of Stockton, which lay on a ferry route at the narrowing of the estuary.

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* See report of Professor Bone in Appendix I. of *Final Report of Coal Conservation Committee* (Cd. 9084), 1918.

The river Tees is tidal four miles above Yarm, which little town was the original bridge port, there being no bridge across the Tees at Stockton till 1762. Until the building of this bridge Yarm had nearly as big a trade as Stockton, though neither could be compared with the Tyne and Humber estuary towns of the same period; for until the opening of the South Durham coal-field by the Stockton and Darlington railway and the exploitation of the Cleveland iron district, the Tees hinterland was relatively unimportant.

After the building of Stockton bridge, the trade of Yarm rapidly dwindled. Before the industrialisation of the area, and before the advent of good roads, both towns were engaged in the shipment of wheat and agricultural produce of the York plain, of lead mined from the Pennine uplands, and with the import of Baltic timber. Little now remains to show that Yarm was ever even a small port. The river between it and Stockton is narrow, winding and shallow, and the contour of the adjacent country made it particularly liable to floods. One of these, the worst recorded, did great damage, and effectually set a finish to the shipping activities of the place in 1771.

Stockton is the natural estuary head, but it has maintained its importance because of the deepening of the river channel, and the making of a short cut through the one considerable river curve below the town. It has no docks, but there are wharves for general commodities. The river will not admit big steamers and the modern activities of the place are concerned with the iron and steel industry. Stockton launches a heavy tonnage of ships in spite of the narrowness of the river here. As a port it has suffered in competition with the modern docks at Middlesbrough and West Hartlepool.

Middlesbrough is one of the youngest large towns in Britain. Its creation as a shipping point dates from the building of coal hoists here on the completion of a branch of the Stockton and Darlington railway to where the channel of the estuary swings to the Yorkshire coast. Its rise as a business centre, and as a port, was entirely bound up with the use of the Cleveland ironstone. It is within a ten-mile radius of over eighty blast furnaces and of many steel works.

As in the case of nearly all great ports, the comparatively safe anchorage and depth of water which allowed of its origin were quite insufficient for the modern developments in the sizes of carriers. Middlesbrough is admirably placed as to its hinterland, but depth of water is maintained only by limiting the tidal scour to an artificially deepened channel between two great retaining walls which now traverse nearly the whole estuary (Fig. 7).

It is unique among British ports. The merest glance at Middlesbrough dock is sufficient to discern its specialised nature. One misses the usual adjuncts of the big general port: the lighters of Hull and London; the wharves, warehouses, and covered sheds of Liverpool; the tramp steamers and small vessels of near Continental shipping.

Instead one sees a great deal of direct rail to ship loading and any number of electric cranes for dealing quickly with steel structures.

The regular lines calling at the docks are big oversea vessels; sometimes passenger liners calling here before leaving the country from London or Southampton Their freights are the iron and steel products requisite for the development of new lands Here are regular lines to the Colonies, South America, and the Far East. Because of the very nature of this traffic, and of the port's connections, great quantities of steel work and machinery are attracted for shipment from other British industrial areas. From this port go the materials which help new countries to help themselves.

Rails, steel ingots, irrigation and drainage pipes, bridge and structural work, and also some textile and engineering machinery, are the chief exports. Iron ore is the chief import.

*The Hartlepools.*—There are two Hartlepools, distinct in the geographical conditions which determined for each its development.

Hartlepool, the old port, combined the advantages of a natural safe anchorage—the most accessible in times of storm between the Humber and the Tyne—and an easily fortified site. West Hartlepool, with its docks, shipbuilding yards and coal hoists, is the produce of the last century only.

Far more coal is shipped from West Hartlepool than from the other Tees ports. In particular, it is the natural outlet for the big, deep, modern collieries which have been sunk within the last twenty years through the Magnesian Limestone in South-East Durham, e.g. at Easington. Millions were spent on sinking the shafts of these collieries, because of water trouble in passing through the sands at the base of the limestone, before a ton of coal was raised. They are now the largest producers in Durham.

All the ports of the North-Eastern region import timber, usually a return freight for coal sent to Baltic ports, but West Hartlepool has the largest timber trade of any of them. Indeed, in the case of pit props, only Cardiff has a bigger figure. Most of this goes to Durham mines, but the Yorkshire, Derby and Notts. coal-field takes very large quantities also. There are considerable iron and steel works at Seaton Carew, just south of West Hartlepool, and the ship-building is the most important on Tees-side. Modern facilities are offered to encourage the fishing industry at the port.

*Ship-building on the North-East Coast.*—We have seen that in the eighteenth century coal was shipped on to keels some distance up the Tyne and Wear, and then transhipped to the sailing vessels lower down. So here was a ready market for the ship-building industry. As British timber became scarcer, there was available Baltic timber, which often formed the return freight of exporting coal vessels, as it does at the present time.

The early boat-building concerns were often quite small. A carpenter, with a reputation for good work, would establish himself on the riverside. Only a few feet of water were necessary for launching the small keels. The timber merchant would supply him with the requisite materials on account, and one or two assistants—his relatives possibly—completed the establishment. Some of the greatest modern firms on the Wear and Tyne are owned or directed by men whose forebears began in this way.

In its evolution the industry must be regarded as dependent upon that of coal shipment, though, of course, in modern times, and especially since the advent of iron ships, colliers have formed only a minor part of the output.

With the use of iron, too, the industry would have dwindled here if the immediate neighbourhood had not offered extraordinary facilities for iron smelting and manufacture.

In connection with this industry, we do well to remember that before the war more than a half of both the volume and value of the world's sea-borne trade was carried in British-owned ships; and, therefore, of course a bigger proportion still in British-built ships, for we have built largely for other nations. Coastal iron and steel works and the larger share of the world's carrying trade helped to make us pre-eminent in this industry; and these special advantages have helped us to retain the lead throughout a period in which our iron and steel production has been far surpassed by Germany and the United States of America.

| *Period.* | *Percentage of World's Tonnage Constructed in U.K.* |
|---|---|
| 1892-4 | 81.6 |
| 1910-14 | 61.9 |

In the years immediately preceding the war, German steel production was organised so as particularly to encourage export, and we began to depend very largely upon her for certain essential elements of structure, e.g. stern frames, cranks shafts, rudders and propeller shafts. Our chief competitors in the shipbuilding industry immediately before the war were Germany and the United States.

The shortage of tonnage during the war caused by the submarine campaign, and the necessity for replenishment, encouraged the United States to make quite special efforts to increase their Atlantic coast plant.

Their great iron and steel production centres were not well placed with regard to coastal industry, but the war conditions temporarily eliminated competition, and its conclusion saw the United States with enormously increased facilities for production.*

We saw how the early coal industry fostered the making of ships on the Tyne and at Sunderland. These are still the chief centres on the north-east coast. As an instance of the concentration of plant, we may notice that at Jarrow on the Tyne ore is imported and the finished ships launched at one and the same works. On Tees-side too, West Hartlepool, Middlesbrough and Stockton have each important ship-building yards.

We have dealt now briefly with the geography of the large industries of this region. Some textile and other industries, important in the area before the days of mechanical power, were unable to attract capital and labour from the predominant activities of the area, and disappeared.

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* Actually during 1918-19 the American output exceeded our own.

There remains, however, one industry which in another form has survived. As in other localities where coal has outcropped in places close to, or actually on, the sea-shore, it has been used from very early times for the evaporation of sea-water in salt pans. The names of two of the wards of South Shields, East Pans and West Pans, are significant.

Much salt was shipped from the Tyne to other parts of the kingdom, and glass and alkali works (both requiring salt as a foundation) sprang up on Tyneside and at Wearmouth.

In the mid-nineteenth century, however, Cheshire salt was being brought by the Trent and Mersey canal connections from Cheshire to Hull, and thence shipped as ballast (by foreign vessels bound to the Tyne for coal) to the Tyne Alkali Works, which, even under these conditions, maintained a struggling existence. At the time of the discovery of the Tees salt area, over one quarter of a million tons took this route, i.e. one-eighth of the total Cheshire output.

However, in 1859, a Middlesbrough ironmaster wished to bore for a water supply just on the south bank of the Tees estuary. The firm was assured by experts that such water would be brackish Water there was in plenty and as brackish as promised, but at 1,200 feet a bed of rock salt 100 feet thick was penetrated. This was the beginning of the Tees salt industry. The stratum was too water-bearing for shaft working, but the bore holes having proved the supply at a less depth just north of the Tees, a method of extraction was evolved, which, unknown to the Tees engineers at the time, was actually in use in similar conditions at Nancy in France. A double tube, with communication by holes bored in the lowest portion, was used. Water was led into the inner tube, and brine, raised the greater portion of the distance by the weight of this water, was pumped up to the top of the outer cube, and evaporated.

Breakages and obstructions in the lower tubes are frequent, and are due to the falling in from time to time of the inverted cone-shaped cavities produced by solution in the salt-bed. The annual output is about 100,000 tons and is rather less than one-tenth of that obtained from the Cheshire beds. The Tyne Alkali Works and the fishing industry are the chief consumers, though there is also a very considerable manufacture of salt especially prepared for domestic use.

# CHAPTER III

## THE NORTH-WESTERN COAST AREA

PROCEEDING now to an examination of the position of the most northerly of the industrial areas west of the Pennines, and directing our attention in the first instance to main structural elements, we must notice that the sequence from the Carboniferous Limestone series of the Pennines proper to the Trias, exhibited in the corresponding area to the east of the Pennines, is here interrupted by an outcrop of Pre-Carboniferous rocks and much igneous material in the lake district.

Fig. 9 shows a core of older rocks almost completely surrounded by material of Carboniferous Age (Carboniferous Limestone and Coal Measures).

Although denudation has reduced the Cumberland mountains to a fraction of their original altitude, they constitute the highest hills in England, and confine the important lines of communication between England and

Scotland within very definite limits. Apart from the very indirect route following the coast, it is only over the hill saddle connecting the Cumberland mass with the Pennines that routes of moderate gradient can be found.

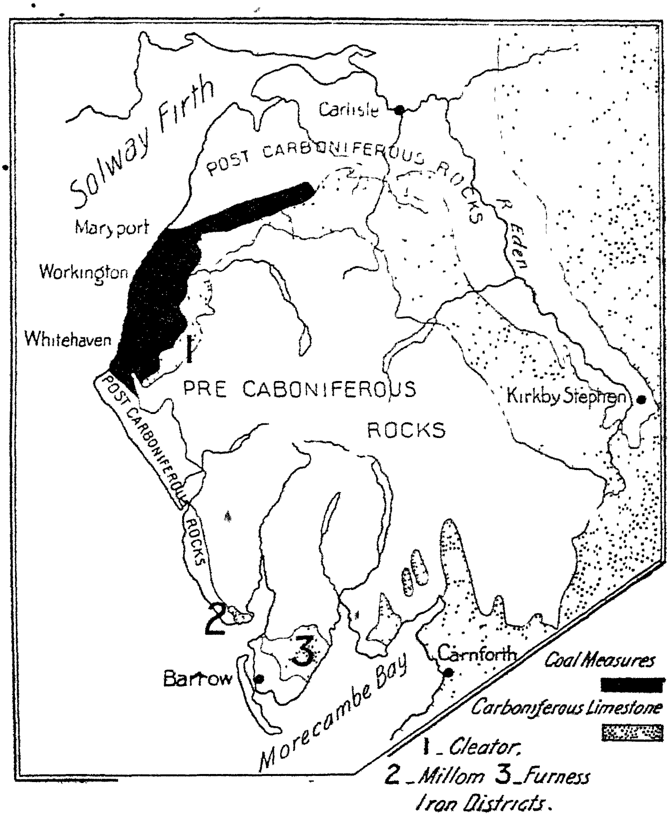

FIG. 9—Cumberland and North Lancashire Industrial Area.

The first approaches this hilly district by the lowland coast strip of Western Lancashire, and, after passing through Lancaster inclines a little to the east to seek a way over the Shap saddle to the lowland of Eden vale and Carlisle. A second approaches by the Upper Aire and Ribble valleys through Hawes and passes Shap a few miles to the east of the first route, and also uses the Eden lowland. A third route, concentrating on Carlisle, is that provided by the Trans-Pennine valley of the Upper Esk and South Tyne. Along this last route, just south of the line of Hadrian's Wall, no good road existed until the attention of Parliament was called to the matter at the time of the Civil War. Then was built the military road connecting these two cities. A railway, originally designed for horse haulage and with over-sharp curves for locomotive traffic, was actually opened for steam traffic in 1838.

Carlisle then, at the lowest bridge of the Eden, is the focus of four routes from England; one via the coast, two via Shap, and one from the Tyne. From it too radiate the three valley lines which cross the southern uplands of Scotland.

Its strategic position, and also the fact that it forms the market centre of a considerable and fertile lowland, gave to the city its old-time importance; but although the concentration of rail routes has made it an important modern junction, it is a little outside the industrial area and maintains the characteristics of the country town.

The larger parts of Cumberland and Westmorland are too high for effective agriculture, and we find a considerable population only in the Carlisle plain and the vale of Eden in the north, in the relatively low ground of Southern Westmorland, and, much more populous than either, in the industrial region running from Maryport to Morecambe Bay, and extending some ten miles inland.

Fig. 9 shows the actual outcrop of coal measures, but a few collieries have been sunk through the newer rocks to the north-east and south-west of this outcrop. Also at Whitehaven coal is worked to a greater distance (four and a half miles) under the sea than elsewhere in the British Isles. Only on the east does the map absolutely define the field. In the north the measures dip under the Solway and reappear in the small coal-field of

Canobie on the Scotch border. However, the extension of concealed coal-fields both north and south is limited by the depth of the seams.

The measures are more faulted than in Northumberland and Durham, and there is both a less total thickness of workable coal, and a smaller area. Both coal-fields are bordered by the sea, but there were no inlets on the Cumberland coast offering even the limited inland shipping facilities of the Tyne and Wear. Above all, the external relationships were all in favour of the earlier and more considerable development of the Northumberland and Durham field, which was more accessible to home and Continental areas of population. There was little coal working at all in Cumberland until the mid-sixteenth century. In recent years the output has been about two million tons.

The field resembles that of Northumberland and Durham in the large proportion of output shipped, though nearly all of this is coast-wise. Large quantities are shipped to Ireland. The chief producing areas are grouped in three blocks, where faulting has brought the main seams comparatively near the surface in the immediate neighbourhoods of Workington, Maryport and Whitehaven. At each of these three ports a small creek indicated the original anchorage, but, as modern ports, they are largely artificial.

Normally, these three little ports between them ship about half a million tons of coal coastwise. There is a considerable coast-wise shipment too of pig-iron and steel products from Maryport and Whitehaven. They have hardly any foreign traffic.

Another analogy with the North-Eastern area is found in the proximity of extensive supplies of iron ore a little to the south of the coal; though the geological formation concerned, the mode of occurrence, the methods of mining, and the quality of the ore are entirely different. There are three main areas of production, and all occur in the narrow concentric outcrop of Carboniferous Limestone, which dips away to the west and south-west of the Cumberland hills.

In the first area, immediately to the east of the coal-field, the ore occurs both in unpersistent scattered beds and also in the form of veins, chiefly developed upon faults in the limestone. The workings are seldom more than 200 feet deep, but on the other hand, open cast workings are very rare. It was in this area, and especially in the neighbourhood of Egremont, that the earliest considerable development took place. At the end of the eighteenth century, large quantities of Cleator ore were sent (*via* sea) to the Carron Works in Scotland.

The second area of production is just south of Millom, where is situated the famous Hodbarrow deposit. Discovered in 1845 and first worked extensively in 1864, this has proved by far the most important single deposit in the North-West. Between 1880-1900 it produced an average of 460,000 tons per annum.

The deposit is at a shallow depth and extends beyond the natural high-water sea-level. Because of the influx of sea-water (notably in 1898) to the workings it has been necessary to build sea-walls on the fore shore.

In the third area, i.e. Furness peninsula, the ore is again found in irregularly placed flats in the Carboniferous Limestone, seldom deep and usually worked from shafts sunk to the side of the deposit with extending levels.

Though of a higher grade and often mined at a less depth than the Cleveland ore, the irregular shape and scattered positions of these beds, and the covering of deep water-bearing glacial drift, make prospecting and mining difficult and expensive.

In all three districts the ore is a fine haematite containing a higher proportion of iron than is to be found in any other largely mined British deposit. It is non-phosphoric. Limestone for flux is quarried in the vicinity of the furnaces.

There are the usual evidences of early bloomeries, but these were not important, and the characteristic of the district was rather its considerable shipping of the ore to Scotch and English iron districts where the expense of working and moderate quality of coal measure ores made a supply of this high grade ore of great value. There was the greater disposition to ship the ore in that the local coal-field does not supply a first-rate coking coal ; and particularly in that period (p. 48), after the introduction of the Bessemer steel, but before the perfecting of the dephosphorising processes.

At that time the Cumberland and Furness ores formed the only considerable supplies of high-grade non-phosphoric ores in the kingdom and the ores themselves and pig-iron made from them were shipped in large quantities to other steel-making areas.*

It has been noted that the local coals are not very suitable for metallurgical coke, and the movement of Durham coke to the Cumberland iron works and of Cumberland ironstone and pig-iron to the Durham steel works has been a heavy traffic on the Tyne gap route, which, though dwindling, is represented to-day. There is the less need now of Durham coke, for after washing and preliminary treatment a very fair coke can now be obtained in modern bye-product ovens from the Cumberland coals.

The earlier blast furnaces were mostly inland in the Cleator district. The more recent plants have been erected on the coast at Workington, Whitehaven, Millom and Barrow-in-Furness. In the main the mines supply the nearest furnaces and a surplus from the district goes to the Carnforth Works. Selected ore lumps are sent for special steels to Middlesbrough and Sheffield or for annealing to Scotland and to the Birmingham districts.

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* Over a quarter of a million tons was shipped annually from Whitehaven in the decade 1860-70.

Ship-building materials and steel rails form the bulk of the steel work produced. Barrow itself is the most important centre both of production and of shipment.

The appendix (p. 247), shows how in recent years the output of this, our one important area of high-grade ore, has dwindled. Much Spanish ore is now imported at Barrow and Whitehaven.

# CHAPTER IV

## YORKSHIRE, DERBY AND NOTTS COALFIELD AND INDUSTRIES

FROM the Aire, about Bradford and Leeds, to within a few miles of the Trent at Nottingham, coal measures are exposed on the eastern flank of the Pennines. The width of the exposed area narrows from about twenty-five miles in the north to less than ten in the south. This is the greatest single exposed coal-field in the United Kingdom, yet it is considerably less than the area to the immediate east where the same measures lie proved, yet concealed under secondary rocks.

We are dealing then with the greatest exposed and with the greatest concealed coal-field; with the area of greatest present production in the United Kingdom, and with the area promising the greatest possibilities of future exploitation. Fig. 10 represents the exposed field. On the west, and for short distances also to the north and south, the coal basin is limited by the outcrop of Millstone grit; but to the north-east, south-east and east, the measures are unconformably overlain by successive coverings of Permian (Magnesian Limestone) and Triassic (Bunter Sandstone and Keuper Marl) formations.

There is here the sequence common to the other Pennine fields, all of which have escaped denudation in synclinal areas of the older carboniferous rocks, and each of which has some portion of its denuded surface concealed under a cover of later rocks.

The especial value of the concealed field here is due to the permanence, thickness and quality of some of the chief seams, which have been proved over a large area and at a workable depth. Before the middle of the nineteenth century no pits had been sunk to the east of the Permian outcrop. Many of the seams worked in the exposed field were dipping at an angle that suggested that pits farther to the east would meet with the chief seams only at depths too great for economic working.

However, as more and more pits were sunk through the magnesian limestone, it became apparent that the general dip to the east was becoming more gradual and that there was an

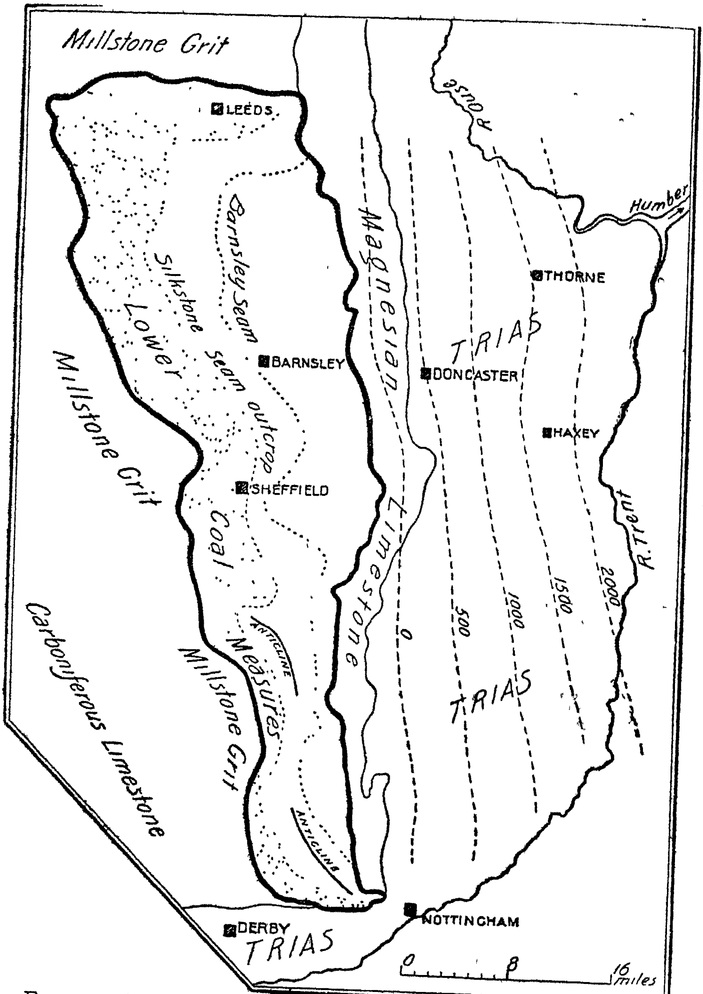

FIG. 10.—Map of Yorkshire, Derby, and Notts. Coalfield. Heavy black lines represent the limits of the exposed measures. - - - - Contour lines showing depth below sea-level of the *surface* of the concealed measures (from data and map given in "The Concealed Coal-fields of Yorkshire and Nottingham," by Walcot Gibson, D Sc., *Memoir of Geol. Survey*, 1913).

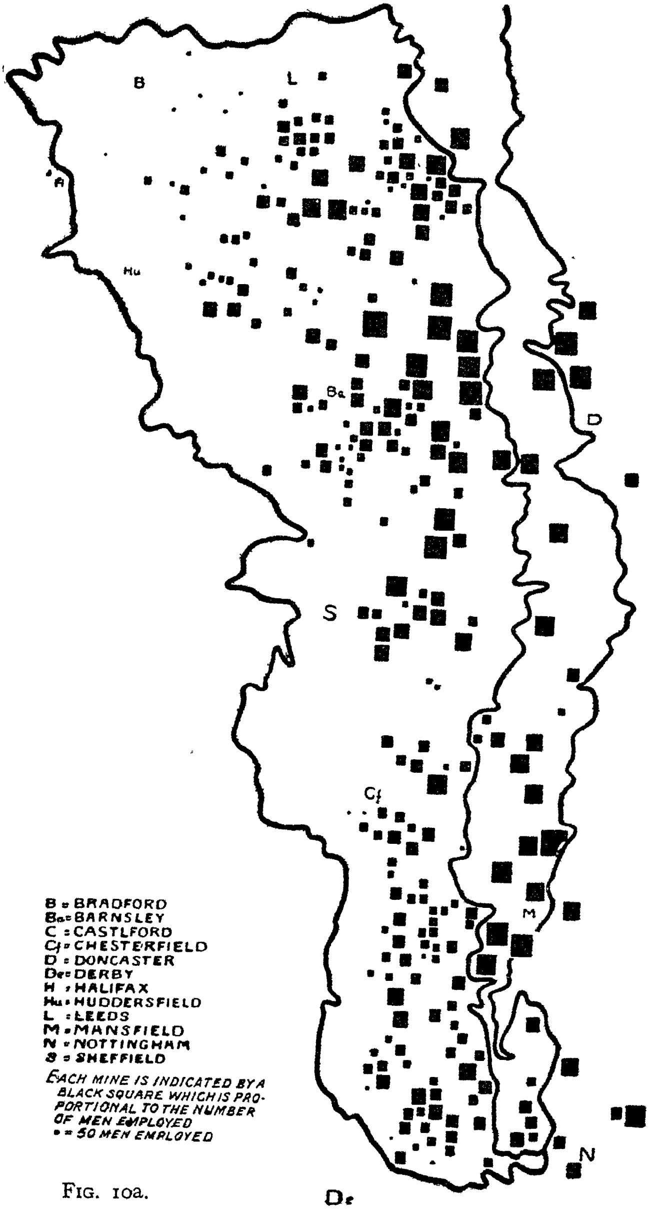
B
L
H
Hu
Ba
D
S
Cf
M
N
De
B = BRADFORD
Ba = BARNSLEY
C = CASTLFORD
Cf = CHESTERFIELD
D = DONCASTER
De = DERBY
H = HALIFAX
Hu = HUDDERSFIELD
L = LEEDS
M = MANSFIELD
N = NOTTINGHAM
S = SHEFFIELD
EACH MINE IS INDICATED BY A BLACK SQUARE WHICH IS PROPORTIONAL TO THE NUMBER OF MEN EMPLOYED
■ = 50 MEN EMPLOYED

FIG. 10a.

absence of such serious faulting as has limited the possibilities of exploitation of the concealed fields of Cumberland and of Lancashire. This gradual dipping of the measures beneath the secondary rocks is illustrated in Fig. 10, which shows the contour lines of the *surface* of the coal measures for depth *below* ordnance datum. The main data for such lines are the records of the various bore holes which have been made in the last twenty years, and which have revealed the coal measures over an area extending up to and a little beyond the River Trent in the east and south.

It will be seen that these lines run almost straight and parallel in a north and south direction, and are fairly equidistant.

The *surface* of the coal measures then is shown to dip gradually and regularly over a large area.

These recent bore holes are deep and expensive. They are made for the express purpose of proving coal (notably the Barnsley seam) before the still greater expense of shaft sinking is undertaken. None of them (directly to the east) has penetrated the full thickness of the coal measures, and there are not yet sufficient data to define clearly the eastern limit of the concealed basin. So also to the north and south; the anticlines which limit the area of the exposed field apparently continue, the one in a north-easterly, the other in a south-easterly direction, with a consequent lengthening of the basin to the east, but the precise limits are as yet undetermined. However, of more immediate importance is the rapid exploitation that is taking place in those areas where coal in workable seams has been definitely proved.

The coal measures are subdivided into upper, middle and lower groups. The upper measures (some 600 feet in thickness) are absent through denudation save in some parts of the concealed field. They are barren of coal.

The middle measures (2000 feet to 3000 feet) contain the most productive seams, especially in their lower half, i.e. between and including the Barnsley and Silkstone seams (Fig. 10). They form the rather greater portion of the exposed coal-field. Beneath the middle measures and out-cropping along the western edge of the coal-field are the lower measures. These contain several workable seams, but usually thinner and less persistent, and therefore of local development only. However, the

Beeston seam is 8 feet thick and provides a valuable coal over a considerable area south of Leeds; the Kilburn seam of Derbyshire is four to five feet thick, and provides a good house coal.

The lower measures contain a greater proportion of hard sandstone than the middle measures, and the denudation of these substantial beds, alternating with softer shales, gives a particular ruggedness to the area at the western edge of the field. Denudation has removed much valuable coal, but, and this was the important factor in the early history of the field, it exposed seams in the deep valleys which could be worked by early mining methods. However, very little coal is raised to-day in the western belt of the coal-field where the lower coal measures (i.e., those below the Silkstone, seam, Fig. 10) are exposed, though there are many small abandoned workings. Nor is at all a large proportion of the coal raised in the narrow belt lying between the outcrops of the Silkstone and Barnsley seams, though many small collieries are working on this area. At present, the most productive part of the field lies between the outcrop of the Barnsley seam and the Magnesian limestone escarpment.

Collieries here reach the whole productive part of the middle measures, (i.e. between and including the Barnsley and Silkstone seams) and at no very great depth. Farther east again in the concealed field mining only became general in the last quarter of the nineteenth century. From the official figures of the men employed, and from an examination of the position of each colliery, the author has ascertained that about one-tenth of the collieries now actually working are on the concealed field, but that these produce rather more than one-third of the total coal raised.

The importance of the Eastern part of the exposed coal measures, and the increasing development of the concealed field, is brought out in Fig. 10a which should be compared with Fig. 10, p. 78. The figure is based on the number of men employed under the surface at each pit. Such a number is not of course at all strictly proportional to the coal brought to the pit-head—but it is sufficiently so to be of use in a graphical presentation. The separate pit outputs are not available in public statistics. There are, of course, large modern collieries employing from 1520 to 2000 men each, e.g. Bentley, Brodsworth, Cadeby, Denaby, etc., about Doncaster Shirebrook and Sherwood near Mansfield and Gedling, east of Nottingham.

Farther east there is a broad belt where the coal measures, and in particular the Barnsley seam, have been proved by bore holes as far east as the Trent.

Actually the most easterly colliery now open is at Thorne, some fifteen miles to the east of the exposed field.

One seam is of special interest in the economy of this field. To the west of Barnsley, and originally worked largely in that area, a seam of coal nine feet in thickness outcrops. Some four feet of this thickness consists of an excellent hard steam coal, much in demand. But what adds to the value of this coal is its great persistence over practically the whole field, though it varies somewhat in thickness and quality. In Nottinghamshire it is known as the Top Hard, and is four to five feet only. Around Leeds it is deteriorated by dirt partings, and is known as the Warren House seam. However, on the central part of the field, and extending to the east in the concealed field, it has much the thickness and character of its outcrop around Barnsley.

It is the first thick persistent coal of high quality which is met with in the eastern borings, and most of the great new pits are working no other coal. Nearly one-third of the miners of Yorkshire are occupied in pits where this is the only seam worked, and if we remember that farther west it is worked in many pits along with other coals, it seems fair to conclude that the Barnsley seam alone is the origin of more than one-third of the total output of the Yorkshire part of the coal-field.

Early workings in this coal-field were of course limited to the exposed field. The accessibility of coal here became the determining factor in the localisation of great industries on the Eastern Pennine flank.

This coal-field is the most definitely "inland" in character of all the Pennine fields, save that of North Staffordshire. Not only is no part of the exposed measure (and therefore of the early working area) within 25 miles of the Humber, but none of the Ouse tributaries were navigable to the west of the outcrop of Magnesian Limestone. There was no water-route connection with the sea.

It is true that the rapid growth of the typical

West Riding industries in the eighteenth century led to their connection by canal with the navigable Ouse, yet these manufactures absorbed the coal output of their own areas, and it was not until the later nineteenth century that the increasing eastward development yielded not only a surplus of coal over and above the needs of the district, but a surplus available progressively nearer the Humber estuary.

This is especially so in the most recent pits of all—those of the Doncaster area. Up to the time of the war much of the output of these mines was shipped from the Humber. Many miles of new sidings and rail connections have been made for this definite purpose. Immediate further development here is bound up with the prosperity of our coal-export trade.

*The West Riding Wool Working Area.*—The outstanding difference between the history and distribution of wool-working industries and of cotton industry in this country lies in the fact that raw cotton is of necessity an article of import. It did not make its appearance here till the seventeenth century, and the industry is located in the area of its initiation.

With wool the case is altogether different. The home clip has always been considerable. In mediaeval times, less advanced in the industrial arts than were our continental neighbours, we filled the humble role of providing them with raw material.

However, to the limit of historic record there is evidence of the making of woollen cloths from the home clip in these islands. And the industry was as scattered as any. A tendency early arose for its greater development in valleys leading from moorland and down country where sheep rearing was more profitable than agriculture, and where the uplands yielded a plentiful supply of water, which was all-important in the manufacture, quite apart from any question of power.

The introduction of new processes by skilled workmen from the Continent fostered the industry in certain districts; notably in the case of the worsted industry about Norwich.

And we are brought at once to another distinction between the cotton- and wool-working industries—in this case dependent upon the distinctive properties of the filaments themselves. Examined under a glass the woollen fibre is seen to be not smooth like that of cotton,* but serrated, and it is these serrations which give to wool its felting properties. An additional strength and consistency is derived from this power of mutual adherence of the fibre of woollen fabrics, and special processes are employed to make the utmost use of it.

If reliance is going to be specially placed on this property, almost the first process after the cleaning of the wool will be that of carding.

Now, in pre-factory days, the cards were simply two boards covered with leather in which wire teeth were set. They were fitted with handles, and the carder placed some wool between them and so moved one over the other as to produce a thin film in which the fibre crossed and re-crossed in all possible directions. But again, the length of fibre varies enormously with the breed of sheep, and where very long fibre was available, an alternative preliminary process to spinning was to *comb* the wool so as to obtain a rough parallelism, and an elimination of any short fibre.

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* A cotton fibre is not, however, of *uniform* section, but its inequalities, caused by unequal shrinking of the single cell of which it is formed, cannot be compared to the sharp edges which characterise the woollen filament. Nevertheless they greatly facilitate the process of spinning.

The fine, short, highly serrated (e.g. merino) wool was carded and spun to a relatively rough woollen yarn. The long fibre (e.g. Lincoln or Leicester) was combed and spun to a smooth worsted yarn. This practice of combing long wools, and therefore of the manufacture of worsteds, was a later development.

It was introduced by foreign workers into East Anglia, which, for this special reason, and because of its easy port connection with London and the Continent, became for a time the seat of the worsted industry in Great Britain.

But wool has another characteristic which has affected the distribution of its manufacture. The uncleaned wool is coated with a film of fat, the greater part of which must be removed in the initial washing processes.

So that, in the original washing of the raw wool, and in the washing and pressing of the woven cloth (i.e. felting processes), great quantities of soft water are required.

This last process was carried out in what were the earliest textile power mills of the country. Long before the invention of mechanical spinning even, water-wheels were used to work the rough wooden hammers with which the cloth was pounded in fuller's earth and water until it shrank and felted sufficiently.

Water for scouring and water for fulling mills was very early in demand, and if we bear in mind their sheep-rearing possibilities, we see that the Pennines began to offer considerable advantages.

The woollen and linen industries came to be of great importance on both sides of the Mid-Pennines, but the particular advantages which South Lancashire offered to the cotton industry engaged the capital and labour there available, and the woollen industry to the west of the Pennines became of relatively little importance, though even to-day the cotton and woollen industries somewhat overlap in the high Pennine valleys. For example, there is a considerable amount of woollen manufacture about Rochdale in Lancashire, and of cotton work in the Upper Colne valley of Yorkshire.

The extension of the use of the great cotton inventions to woollen fibre, and the use of water for power, especially in the early spinning frames, gave an additional value to the Pennine sites. The occurrence of coal for steam power confirmed the localisation.

Norwich gave place to Bradford; the cottage industries all over the country were represented by the mills of the Yorkshire Calder and Colne valleys. Even so, the concentration is not so complete as in the case of the cotton.

Some 80 per cent of the workers in wool of the United Kingdom are occupied in the West Riding of Yorkshire; and another 5 per cent. are employed in what is practically the same area, just over the summit level on the Lancashire side.

The Cotswold valleys of Gloucester and Wiltshire, and the Tweed and Cheviot districts of Scotland, are remarkable for the high quality of the goods made. They are at a geographical disadvantage with regard to economic output. Their relative importance has sadly dwindled, and they could not compete with the West Riding in the manufacture of the cheaper woollen cloths, or in worsteds at all. They thus specialise in the very highest class of woollen goods.

If we examine a little more closely the West Riding woollen area, we find that it is largely limited to the Calder and Colne basins. Fig. 11 shows the river system and all the centres of population where the woollen industry is of any importance. The extention of the industries far up the streams, beyond even the outcrop of lower coal measures,* is a comment on the importance of a soft water supply. The extension north is limited by the absence of coal working north of the Aire.

As in the case of the cotton industry the multiplication of independent manufacturing processes, e.g. combing, spinning, weaving, dyeing, finishing, and the inter-relation of the products of these processes, make for the concentration of the whole industry in as small an area as possible. The Calder and Colne basins provide a sufficient area, and, having in mind the historical requirements of the industry, it would be difficult to select an area which could have proved more suitable to its development.

The Aire is the largest of the Ouse tributaries, and its headwater tributaries have cut back far into the Pennines which are here at their lowest. The waters of the Colne and Calder basins are relatively soft. Connection with the Lancashire valleys was easier here than it would have been farther to the north,

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*e.g. above Halifax.

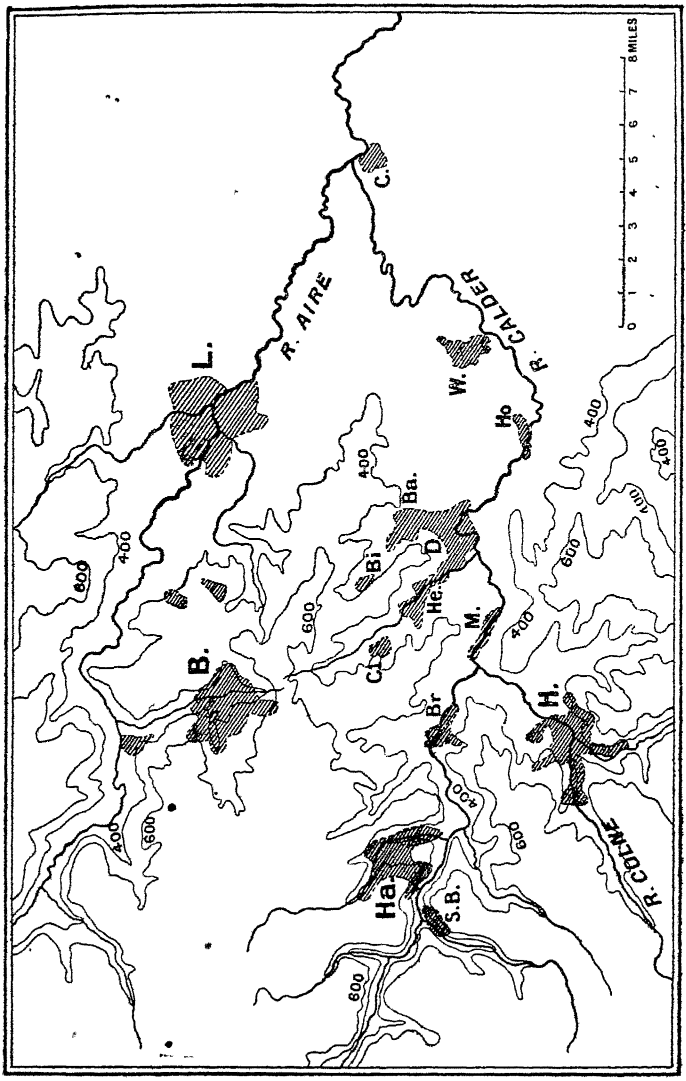

FIG. 11.—Diagram showing the position of the West Riding wool-working towns in relation to the Upper Aire basin. Many of the actual factories are strung along the stream-sides between and around the towns marked. Contours shown—400 and 600 feet.

B. Bradford, Ba Batley Br. Brighouse, Bi Birstall; C Castleford; Cl Cleckheaton, D Dewsbury, H Huddersfield; Ha. Halifax, Ho. Horwich. L. Leeds, M. Mirfied, S B. Sowerby Bridge, W. Wakefield.

or to the south. Across this textile area ran the first Trans-Pennine canals and railways.

In the organisation of the modern industry much local specialisation has arisen. Bradford is the centre of the wool-combing and worsted district. We should notice that length of fibre is no longer essential for the manufacture of a worsted yarn. The modern combing machine can deal with short staple wool. In the main, however, the distinction remains. Worsteds are fabrics made of wool combed before spinning, whatever the length of the fibre. The combed portions of wool are called "tops," and, as a semi-manufactured product, they may go to the worsted-spinning mill, or they may be exported as "tops" simply. The combed out short wool or "noil" returns to the woollen industry.

The weaving of worsted from worsted yarn is more scattered over the whole area, but it is most important in the Bradford district. A great deal of yarn, too, is exported as such, and there are large sendings to the hosiery works of Leicester and the Midlands.

Woollen spinning and weaving are scattered over the remaining area. Huddersfield produces good woollens and worsteds. The

Colne valley above Huddersfield is the district of cheap "tweed" and woollens generally. Dewsbury and Batley have acquired pre-eminence in the manufacture of shoddy; Halifax in the making of carpets, and the remaining areas have a very miscellaneous production.

The largest town and the natural route centre of the district is Leeds, but this city in no sense occupies a position corresponding to that of Manchester in the cotton industry. It has large spinning and weaving factories, and is the most important centre of ready-made clothing. It has also important leather factories and great engineering works. On the outskirts, at Hunslet and Armley, are blast furnaces and steel works. The only other blast furnaces of this district are those of the famous Low Moor (near Bradford) Ironworks, which originally depended on the local coal measure ore, and still produces a very tough wrought iron of fine quality.

Keighley in the north-west extremity of the district, specialises in textile machinery, and Wakefield may be regarded as the most easterly of the considerable textile centres: a good deal of spinning takes place there.

*Sheffield and the South Yorkshire Iron and Steel Industry.*—The case of Sheffield supplies peculiarly interesting instances of the factors which localise industry.

Its earliest important production was of cutlery, but this implies the skilled use of special steels, and Sheffield has become the centre of the science of Ferro-Metallurgy.

The toughness, the hardness at high and at low temperature of an iron product are found to depend upon the extent to which certain elements are present with the iron, and upon the physical and chemical nature of these attachments. The most important of the accessory elements is carbon itself, and steel processes from the cementation onward have been concerned with the absorption and retention by iron of just the right quantities of carbon in the right state. More recently it was found that by the use also of certain elements of chemical attributes like to those exhibited by iron itself—metals such as nickel, manganese, chromium, tungsten and molybdenum—products could be obtained of a very great range of usefulness. Such are the special tool steels, the extraordinary hardness of which must be as little as possible affected by the high temperature which their use engenders.

The identification of the district with work on Special Steels is indicated by the prominence given to metallurgy in its modern university. Also many epoch-making experiments in special steel production have taken place in the great Sheffield works.

It may be possible—it is certainly not easy—to find in the British Isles a more fitting environment for the early industry than that supplied by the neighbourhood about Sheffield; though, save for all that is implied by the term "geographical inertia," the modern industry could as well exist in almost any of our other industrial areas; and, were the work to start *de novo*, could probably be more economically carried on upon the coast. Let us examine a little this early environment.

Fig. 11 gives us the clue to the whole matter.

Notice the concentration of five streams of high gradient upon Sheffield. In their valleys a local ore was available.

The forested valleys provided charcoal; the streams power for blast, for tilt hammer and grinding mill. With the depletion of the forests, it is true, came the dependence upon

Swedish bar-iron, but when this occurred the greater portion of our iron industry was

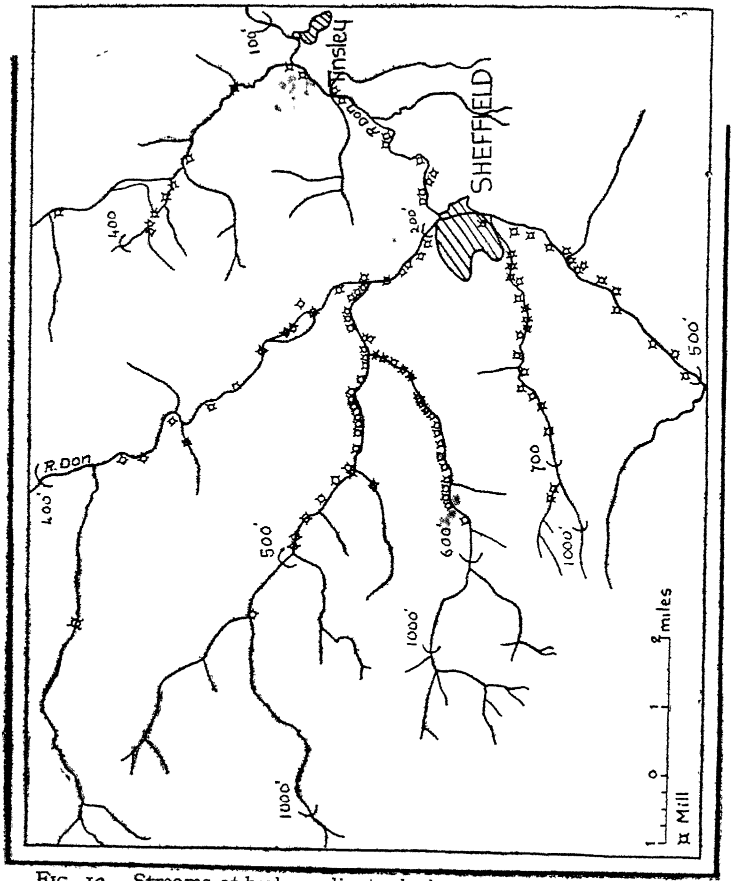

FIG. 12.—Streams of high gradient which concentrate upon the site of Sheffield. The points at which certain contour lines cut the stream are shown to indicate the gradient. The water mills shown were those existing in 1828 and were chiefly forges and grinding mills.

dependent upon this source. With the use of coal for smelting and finishing, and finally for power, the district had the advantage of being on the coal-field.

Sheffield lies between the lower coal measures exposed in the rugged country which characterise these tributary western valleys, and the more productive middle measures of softer rock materials and milder relief which lie to the east. Separating the lowest seam of the middle measures from some workable seams in the lower measures are beds of particularly thick and coarse sandstone. However, the streams which concentrate upon Sheffield have cut steeply through this, and upon their valley sides the coal outcrops of the lower measures were worked by adit and shallow mines. The middle measures now furnish the bulk of the supply, but in earlier days this concentration in the valleys themselves of coal for forge and finishing work, of iron ore, and of stream gradient, sufficed.

Fig. 12 shows the water mills (chiefly cutlery works) existing in these valleys in 1828. The contour of the valleys lent itself to the construction of the little mill dams and weirs which appeared above each mill. If one walks up the Locksley valley to-day, one may notice the string of small mill buildings—many of them now disused—which mark the site of the older industry.

The modern industry requires great quantities of a suitable silicious material for conversion into fire-bricks for furnace linings. Such sandstones occur somewhat frequently in rocks of various periods, but there is none more suitable than the gannister of the lower coal measures to the west of Sheffield.

The name gannister is of local origin, but is now applied to many other refractory materials of different and generally inferior qualities. It is a hard sandstone worked in some of the western valleys of the lower measures which cradled the early industry, and was at one time used as road metal. It is pale blue to dark grey in colour, and is distinguished from other refractory quartz rocks by its fine texture, even grade and splintering fracture.

There is enough in these surroundings to explain the development of the industry in South Yorkshire, but this area has entirely outgrown the supplies of its immediate environment.

The blast furnaces of the Sheffield district no longer use the thin bands of coal measure ironstone, but rely on supplies from Lincolnshire and abroad. The steel and foundry works of the district too are not fully supplied by local blast furnaces, but take pig-iron from Cleveland, and from Scunthorpe and Frodingham (Lincolnshire).

For generations Sheffield has depended upon charcoal-smelted Swedish bar-iron for some of its very special steel work, and the import continues, though in diminishing quantities, for the war, in practically cutting off supplies, led to the demonstration (by experiments conducted at Sheffield University) that we could provide a British-made iron in every way as suited to the purpose.

To the south of Sheffield the exposed coal-field narrows considerably, and the gradual dip of the measures to the east, is interrupted by two marked anticlines. A northern one enters the field from the north-west of Chesterfield, passes to the east of this town in a north and south direction, and then turns south-east in the direction of Mansfield.

The second lies farther to the south with its axis parallel to the Erewash valley, and extends to the southern limit of the coal-field.

Denudation has exposed a portion of the coal measures comparatively rich in iron ore.

Here again, the proximity of ore, fuel and flux made these districts in Derbyshire important iron-producing areas in the period when we depended most largely upon the coal measures for our supplies of ore. It is still a noteworthy blast-furnace area. The chief centres are Chesterfield, Alfreton, Staveley, Stanton and Clay Cross (Fig. 13).

These no longer use coal-measure ore, but, like the other inland iron districts, are dependent upon supplies from Lincoln, Leicester and Northants. Their products are used in the foundries and engineering shops of Derby, Nottingham and Chesterfield, and a surplus of pig-iron goes to the Sheffield district.

*Derby and Nottingham.*—Derby occupies a strategic position at the debouchment of the Derwent upon the Trent plain. The River Derwent, though always unnavigable, provided the most extensive north and south valley route within the Pennine area (Fig. 13). Derby became the chief market town of the valley products, e.g. of lead, dairy produce and textiles.

Before lead was cheaply imported our chief

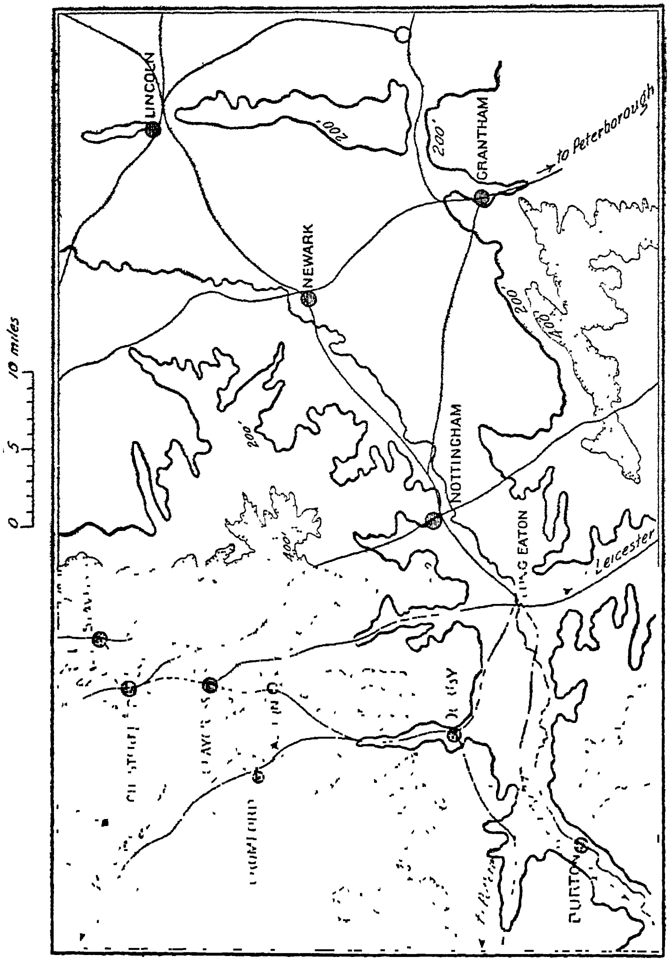

FIG. 13.—Derby and Nottingham in relation to Midland valley routes.

source of supply was the carboniferous limestone of the Pennines. The ores occur in scattered irregular masses, often with only a slight cover, but so irregularly placed as to make mining a somewhat hazardous undertaking. The most accessible ores have been mined and the work is now almost entirely abandoned; but at one time there was extensive mining, not only in the Southern Pennines, particularly in the Peak district and Upper Derwent valley, but also in the Pennine limestones of North Yorkshire, Durham and Northumberland.

In the eighteenth century lead was an important article of export and of coast shipment from all our ports from Newcastle to Hull. In Derbyshire it was marketed largely at Chesterfield and at Derby. From the former it moved by pack-horses to Bawtry, and thence to Hull. Derby supplied the Midlands and London by land route. As the chief market of the South-Eastern Pennines, Derby attracted streams of traffic from the bridge towns of the Trent, and its nearness to the broad valley of this river has facilitated east and west traffic also. This character of route ganglion has been much emphasised in the railway era, for the Derwent valley and its branches form a portion of the natural route from Burton to Sheffield, and from Leicester or Trent Bridge to Manchester. Each of the railway companies has its works at some large junction, and those of the Midland are the greatest engineering works of Derby.

Early attempts were made to render the Derwent navigable to Derby, but these were ineffectual, and it was not till 1771, when the Trent-Mersey canal was built with a branch to Derby that the town had a waterway to the sea.

The Derwent valley, too, is interesting in being one of the few regions outside Lancashire and its borders where cotton-spinning is prosecuted. Arkwright, in seeking a source of power for his new roller-spinning invention, used the water drainage from some old lead workings at Cromford. Cotton-spinning by water power soon became associated with several places in the valley, notably at Belper, Glossop and Millford. The Lancashire merchants would not just at first accept this yarn, and a surplus was left to supply the hosiery and lace works of Nottingham, for which an even hard quality was a recommendation.

Silk manufacture was a domestic industry in the Derwent valley in the seventeenth and eighteenth centuries, but it dwindled with the competition of the more favourably placed French industry, though till a few years ago a silk mill was still working in Derby.

Nottingham is situated on the Trent, where it emerges from between the South Pennine and Midland hills, and begins to curve to the north in the great Trent-Ouse plain (Fig. 13).

Unless a river be interrupted by some definite fall or obstruction, it is seldom possible absolutely to locate its limit of effective navigation for any given historical period. We know, however, that navigation has always been possible, though difficult, for some distance above Nottingham; e.g. the Trent-Mersey Canal connected with the river at Shadlow, which is some ten miles above Nottingham.

At the present time there are usually only a few feet of water available up to Nottingham, though by the deepening of the channel and the construction of weirs now in progress it is hoped to bring trains of large, tug-drawn barges up to the town, and that it may regain its old-time position of a considerable inland port.

In pre-railway days, the Lower Trent and Ouse combined to form a noteworthy link for traffic moving north and south, e.g. from London to York. Strategic and economic importance accrued to the junctions of land and water routes at the great bend of the river.

The precise causes leading to the earliest use of the exact sites of Nottingham and of Newark are not easy to determine, but the navigable stretch of water to the north, the bend in the river, the growing differentiation between the types of northern and southern productions must all have fostered the development of some such towns on this stretch of the Trent. The site of Nottingham, however, offered two types of natural advantages for town development, the one operating in its earliest history, and the other since the industrial era.

Immediately to the north of the Trent here, there is a little semi-circle of hill offering every facility for protective defence. Also, the river narrows slightly at this point. A bridge existed here in A.D. 920, and a Norman castle appeared on the strategic hill site to the west of the town.

The consequent nucleus of settlement was soon influenced by the larger geographical considerations. The Trent has a considerable flood plain—even for some distance above Nottingham—and this was so generally unsuitable for settlement that there are few towns or villages actually on the riverside. It is only in recent years that Nottingham itself has extended right down to the river.

The western half of Nottinghamshire has the Bunter sandstone exposed at the surface—save for occasional patches of glacial drift. This porous formation has always yielded poorer soils than the Keuper Marl country to the east, as the uncultivated areas in Sherwood Forest and parts of the Dukeries bear witness. It has, however, provided a deep well-water supply for the more populous surrounding districts, and, in particular, for Nottingham itself.* With the continued extension of coal mining in the east, its own population, too, is increasing.

The strategic site, the ferry, old road and early bridge, the junction of river and road route—these are the factors in the early development of the town; but it is in the eighteenth and nineteenth centuries that its most rapid growth occurred. At the extreme edge of the coal-field it stood, a place of exchange between the agricultural South-East and the industrial North-West. A particular direction was given to the textile industry here while it was yet domestic in character by the invention and early use of the stocking frame. This machine was soon largely used locally, and the district began to specialise in hosiery, and used in the eighteenth century the cotton and silk yarns of the Derwent valley. An adaptation of the stocking-frame led to the making of machine lace, which rapidly became the characteristic industry of Nottingham. There has never been much yarn spun in Nottingham itself. As in the case of Leicester, its industry is subsidiary to those of Lancashire and the West Riding.

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* This supply has now to be supplemented by water from the Pennines.

# CHAPTER V

## HULL AND THE HUMBER

WE gain a useful conception of a town by regarding it as a living organism, capable of growth and decay, and its development as being affected as much by its geographical environment, favourable or otherwise, as by the energy, originality and foresight of its inhabitants. Such a conception of a town has become a commonplace of modern geography, but to make it more completely fruitful we must press our comparison of town and organism a stage farther, in that both, in their development, are subject to the competition of units like to themselves, and in that the requirements of both vary at different stages of their growth.

It is in the light of such a comparison that we will examine the geographical environment which has conditioned the evolution of the port of Kingston-upon-Hull.

We will first remind ourselves of the salient geographical features of the hinterland of the port, treating them in very broad outline, and mentioning only such details as ultimately affect or have affected the port itself.

The Humber estuary is the outlet of the Trent and Ouse catchment basin (i.e., of one sixth the area of England and Wales), and in a very special sense this basin was in earlier times the hinterland of the port.

Up to the natural gateway cut by the estuary through the west-facing chalk scarp in the neighbourhood of North Ferriby (Hessle) (Fig. 14) the Humber never has a width of less than one mile, and its deep-water channel swings to the marked concavities where now are situated the ports of Hull and Immingham. The tidal range is very considerable (about 19 feet at Hull and 19 feet 6 inches at Immingham), and apart from these places low water usually reveals great stretches of sand bank which have always rendered localities on the estuary side inaccessible to shipping.

On such wide estuaries, with their big tidal range, strong tidal currents (3 to 4½ knots at Hull) and lack of shelter, early settlement dependent in any way on shipping would only be possible where the entrance of some minor stream gave the necessary channel of approach and shelter from storms. Such conditions led to the little shipping settlements of Hedon, of Beverley, and of Hull itself.

The river Hull, a tidal stream, is navigable some distance above Hull town, and it is only in accordance with the general order of port development that we shall find the older settlement, at or about, the limit of navigation. From the ninth to the twelfth centuries Beverley was more important than Hull. It was the port of Holderness, but without river improvement, far in advance of anything the times could offer, it could not become the port of the Trent and Ouse basin as was possible in the case of Hull.

Beverley is situated on the chalk about one mile from the marshy surroundings of the river Hull, with which it is connected by a canal—the Beverley Beck—opened in the fourteenth century, after the weirs which had been allowed to obstruct navigation on the river Hull had been removed.

We shall see that the river Hull for the two miles in which it flows through Hull city is a centre of very great activity, but above this it

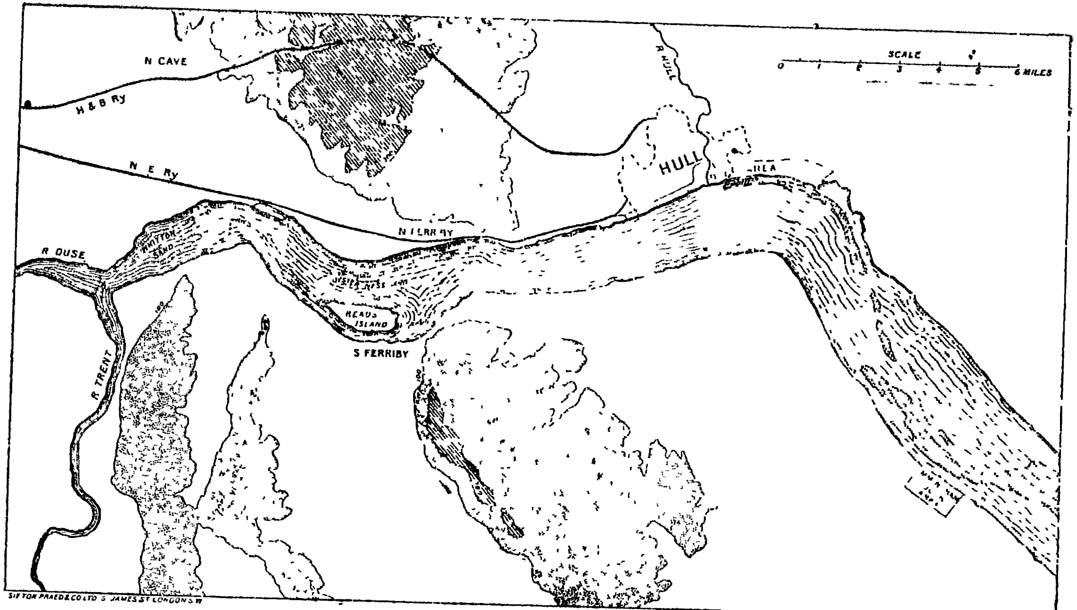


FIG. 14.—The Humber about Hull.

Land above 100′, ⋅⋅; Land above 300′, ☰☰, 30′ Channel, //////

(Reprinted, by permission, from *The Scottish Geographical Magazine*, Vol. XXXV, May, 1919) is to-day chiefly important as providing a means whereby the very large number of trawlers built at Beverley are floated to Hull.

Fig. 15 shows a plan of Hull in the fourteenth century. Here we can note the chain-guarded harbour formed by the river Hull just where it enters the Humber proper, the Hull side wharves, the old walls and the moat,—a cut developed from an old stream and joining in a crescent the river Hull to the Humber—the citadel offering protection from the river side, and the many gardens for which in those days there was still room within the walls.

In the earliest stage of settlement Hull was merely a place of shelter, the Wyk or harbour of the Danes. So much of the land quite near to Hull was marshy, and Holderness generally so isolated by the Yorkshire moors and wolds that one doubts whether Hull ever had much trade overland until railway development. In its earliest stages it had to compete with the (at that time) seaports of Lincoln (via the old Fosse), Doncaster, about the limit of the navigation of the Don, and York, near that of the Ouse, and also with Selby and Gainsborough, lower down the Ouse and Trent respectively. But very early it derived importance from the

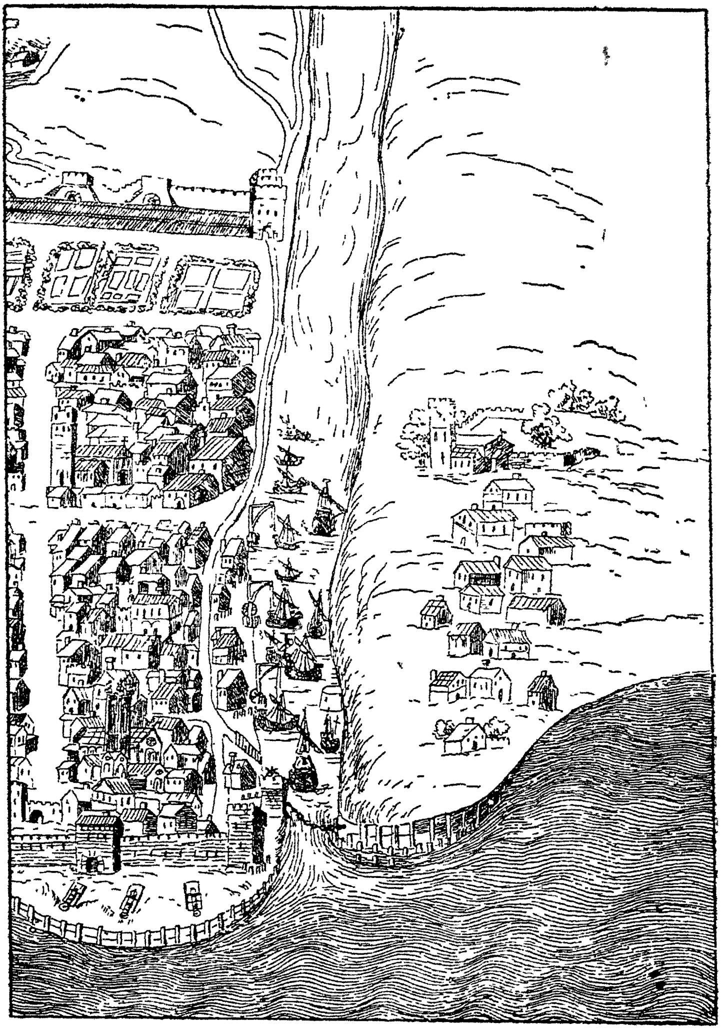


FIG. 15.—Plan of Hull in 14th Century, from *The Evolution of Kingston upon Hull, as Shown by Its Plans*. By T. Sheppard. Pub. A. Brown & Sons, Saville Street, Hull.

fact that even the small ships of those times were often unable to reach the river ports proper, though these could be attained by river craft with goods which had been transhipped at Hull. The port is called Hull in the Pipe Rolls, and Kingston-upon-Hull after the visit of Edward I on his way to the then more important town of Beverley.

Thus we are brought to the second stage of the development of the port, in which it became the chief point of transhipment as between river and ocean craft. Before dealing further with this aspect of the port, let us consider the geographical conditions which made such development possible. Above the junction of the river Hull and the Humber, the estuary narrows considerably to the natural gateway through the chalk ridge, which is plainly defined right down to the water's edge at North and South Ferriby. The consequent constriction of the estuary (one mile here in width) together with the inconstant relation between the flood times of the Ouse and Trent have been instrumental in the formation of a large number of banks—e.g. Whitton Sand, Oyster Ness Sand, and Read's Island. Just above Whitton Sand the Trent joins the Ouse, which runs from Selby almost due east to this point with only the wide bendings of a tidal river (Fig. 14).

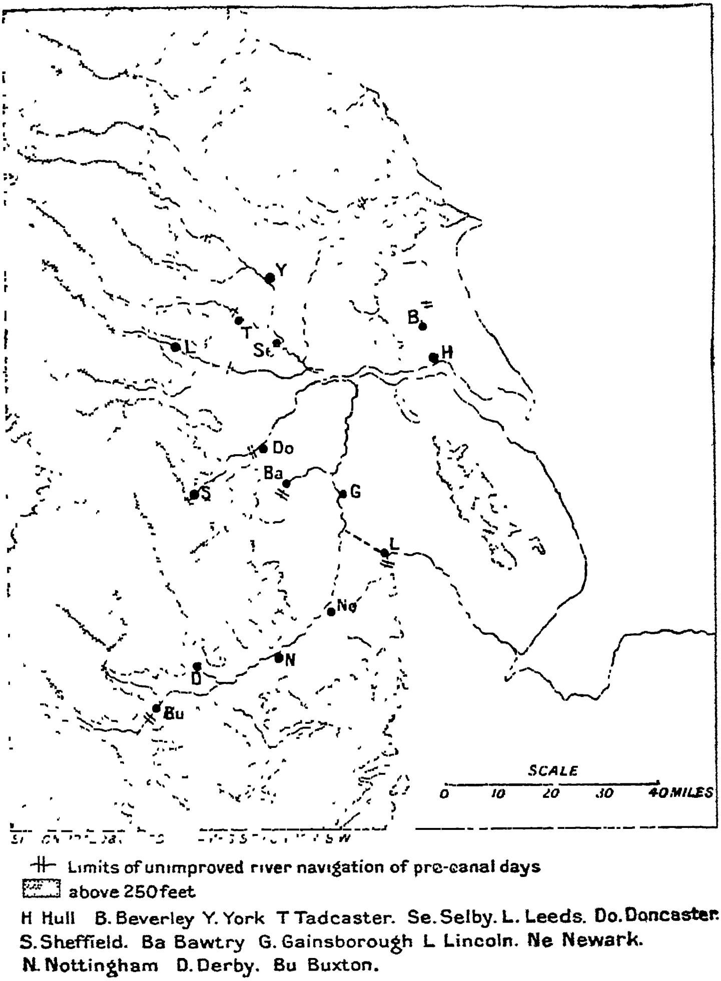
The land north and south of this stretch is very low-lying, and much has been reclaimed under the direction of Dutch engineers.

Exceptions to the complete evenness of the Ouse plain are the morainic deposits, notably the great crescent passing through York, and also the isolated outcrops of older rock from underneath the alluvial deposits at Crowle, Thorne, Snaith, etc., where the consequent slight rise of level above marshy surroundings probably accounted for early settlement.

In the main the soil of the great plain is fertile, as is evidenced by the heavy wheat and barley crops of the northern portions, and the potato and root crops around Goole. Some low-lying land of lesser fertility around the Lower Ouse has been immensely improved by the interesting practice of warping. In this process the tide waters of the Ouse, the most silt-laden river of the kingdom, are allowed to settle for a period over reclaimed low-lying land, much to its subsequent advantage. But ignoring details, the salient fact is that just above the junction of Trent and Ouse we enter a great plain extending some forty miles north-west to Boroughbridge, the limit of navigation on the Ure, and forty-five miles to Newark in the south.

It is sharply contained on the east by the oolitic and chalk scarps revealed in the Cleveland Hills, Yorkshire Wolds and Lincoln Ridge—hilly areas which forbid easy access to the sea, save by the estuary itself; while on the west the many south-east flowing tributaries were never navigable beyond the low scarp of magnesian limestone, which runs from north to south through Yorkshire and Nottinghamshire (Fig. 16).

Light will be thrown on the difficulties of early road traffic and the consequent importance of river navigation, circuitous and uncertain though it was, if we consider some of the well-established trade-routes which centred on Hull in pre-canal days. The considerable towns of Gainsborough, Bawtry, Lincoln, Nottingham, Selby, York, Tadcaster and Boroughbridge traded naturally enough by river route with Hull, but it is with some surprise that we learn of large quantities of goods from Chester and Lancashire in their journey to London, being brought to the Trent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╫ Limits of unimproved river navigation of pre-canal days
▨ above 250 feet
H Hull B. Beverley Y. York T Tadcaster. Se. Selby. L. Leeds. Do. Doncaster.
S. Sheffield. Ba Bawtry G. Gainsborough L Lincoln. Ne Newark.
N. Nottingham D. Derby. Bu Buxton.

FIG. 16.

by pack-horse as far as Burton and thence by river for transhipment at Hull. Or again we may instance the heavy traffic between the Sheffield district and London, which was to a considerable extent maintained by pack-horse from Sheffield to Bawtry (Fig. 16), the one-time river port on the Idle, and thence by the Trent for shipment at Hull. In the second stage of its growth then we see Hull the natural collecting and distributing centre for the river-side towns of the fertile Trent and Ouse plain, and for industrial districts at no great distance from parts of this navigable system.

The localising of industries in positions specially favourable to production, which was a feature in the change from cottage to factory conditions, and from hand to power production, involved, and was dependent upon increasing transport facilities. It was the provision of such facilities in Yorkshire under the pressure of a growing industrialisation which influenced the growth of Hull in its third stage.

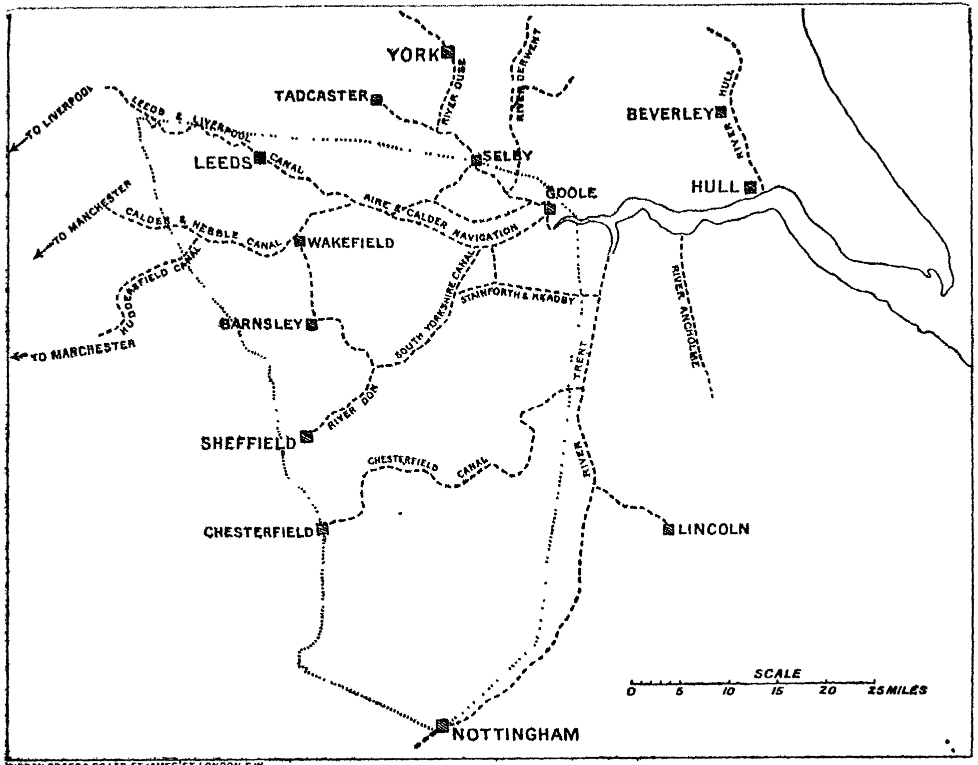
The upper portions of the Ouse tributaries, that is to say where they cross the Millstone Grit and coal measures, are of high gradient, and they were extensively used for power mills before the steam engine had been rendered practicable. This was notably the case in the Sheffield area for the iron industry, and again where the Aire and Calder, the most considerable of the Ouse tributaries, cross the Pennine Uplands, the limestone has not been exposed as is the case north and south of this area, and consequently the upper streams of this basin not only supplied power, but plentiful soft water, two important factors in the settlement there of the West Riding woollen industry. The later use of steam power in these industries, though it withdrew the centres of production farther down the valleys and fastened them on the coal-field proper, yet left them in the main above the limits of navigation, and therefore cut off from direct water communication with the sea.

Now bear in mind the fact that extensive scientific road-making hardly preceded the railway era, and that the badly made, badly repaired, parochially managed roads of the seventeenth and eighteenth centuries were quite unsuited to the rapid growth of traffic of this period, and we may realise what anxiety there was to connect the West Riding centres of production to the nearest navigable points of the Ouse or of its tributaries. Thus the first considerable river-improvement scheme in Yorkshire was concerned with the deepening of the Aire and Calder rivers and with avoiding meanders by means of cuts, so that navigation might reach the industrial centres of Leeds and Wakefield, which two towns were thus connected to Hull by waterway in the very early eighteenth century. One of the main reasons for the undertaking was that the products of the woollen industry might more easily reach Hull for transhipment to London and the Continent.

A little later, in 1782, the improvement of the Don navigation, almost to Sheffield, brought the iron industry of that district into direct communication with Hull, and incidentally led to the decline of the Idle and Bawtry route previously mentioned. The early improvement of the lower Aire was never satisfactory, and in 1774 an entirely artificial waterway was made from Haddesly across country to Selby, thus adding to the importance of that town. Finally, in order to attain a more direct route to a point on the Ouse which should be navigable for ocean-going vessels, the great canal from Knottingley to Goole was built in 1826 with considerable docks at the latter place. Here we have an instance of a very considerable town settlement resulting immediately from an entirely artificial work.

The promoters of the cross Pennine canals made great show of the advantage which would accrue from a through water connection between Liverpool and Hull, and incidentally between the industrial areas of Lancashire and Yorkshire, mentioning very properly the differentiation of production and requirements of the two areas as a potential factor in traffic. But as a matter of fact the actual cross-Pennine routes with their stairs of locks, narrow tunnels and great reservoirs consequent upon increasing gradient, were much the most difficult and expensive to engineer. They were consequently built last, and hardly preceding the railways, they never had much through traffic, and carry almost nothing to-day. Such trade as these canals now bear is confined to the industrial areas some distance on either side of the summit levels.

The complete canal system converging upon the Humber is shown in Fig. 17.



SIFTON PRAED & CO. LTD. ST. JAMES'S ST. LONDON, S.W.

FIG. 17.—The Canal System which converges on the Humber. The estimated limit of the Coal-field is shown by a dotted line. For continuation of trans-Pennine canals on the Lancashire side see Fig. 20.

Thus to the Trent and Ouse plain, which had naturally the most extensive navigable river system in England, were added many miles of artificial waterways connecting the Yorkshire, Derby and Notts coal-field with the one very considerable port between the Tyne and Thames, and providing at a period when no other such effective transport facilities existed for the necessary exchange of agricultural and industrial products, and for the growing traffic of the West Riding with London and with Continental ports.

Before dealing with the geography of the modern port we should note a fourth stage of development in which two great changes are evident. The increase in size of vessels and particularly the use of iron ones, together with the increasing volume of trade, made it necessary to supply means whereby ships could be in harbour for considerable periods without grounding, and cargoes could be dealt with at quay-side without change of level. These considerations led to the dock era in ports of considerable tidal range. Referring to our old plan of Hull (Fig. 15), we see the town confined by a crescent of moat, and this depression joining the Hull to the Humber became the site of the earliest docks. Thus the Humber opened in 1807, Princes 1827, the Railway 1846, and then when these proved insufficient for the volume of traffic, Victoria dock was cut out of the unoccupied low land to the south-east of the town. For further increase no land in the immediate vicinity was available, but engineering science of this date was well enough equipped to deal with the problem of a great embankment in the estuary itself, piling up the water against the town in the long line of the St. Andrews (1883), and the Albert and William Wright (1869) docks.

The town was now completely surrounded by docks and the later deep-water accommodation had perforce to be constructed farther down the stream. The Alexandra (opened in 1886), and farther down again the great new joint dock opened in 1914. This last is the joint property of the North Eastern Railway and Hull & Barnsley Railway Companies. The Alexandra dock belongs to the Hull & Barnsley Railway Company, and the remaining Hull docks are the property of the North Eastern Railway.

Among the earliest of the disconnected unorganised fragments of track with which the railway era in this country opened, were those connecting Hull to Selby and the industrial West Riding. Railway construction was easy here across the Ouse plain and there was just room to push forward to Hull between the chalk scarp of Hessle and the estuary without either tunnel or serious gradient. The later Hull & Barnsley line had to seek a partial gap farther north, via North Cave, and even so a tunnel was necessary (Fig. 14).

The canals in agricultural areas, for example the Market Weighton, Pocklington, and Ripon canals, and also the trans-Pennine system near the summit levels have so suffered in competition with the railways as to be practically derelict.

The relation between the remainder and the present trade of Hull will receive some comment in the notes on the present trade of the port which follow.

*Modern Trade of Hull.*—So far we have endeavoured to account for the town growth of the past, relating it chiefly to the waterway connections of its hinterland. We must now indicate the leading features of its present trade and show how these can be related to its geographical position. We must call a few figures to our aid. First of all how does it stand in relation to other British ports as to the value of its trade?

VALUE £ MILLS. 1921

| | Import | Export | Total |
|---|---|---|---|
| 1st London | 415 | 191 | 606 |
| 2nd Liverpool | 241 | 286 | 527 |
| 3rd Hull | 60 | 31 | 91 |
| 4th Manchester | 52 | 35 | 87 |
| 5th Glasgow | 33 | 62 | 95 |

Such figures are only one way, and not a very satisfactory one, of gauging the trade of the port. They are unsatisfactory here because they neglect the great coast-wise traffic enjoyed by Hull, and neglect also the greater portion of the fish traffic (because only imported fish, that is, mostly Norwegian herring, affect these figures), and further they give insufficient indication of the immense traffic of bulky but comparatively cheap commodities, such as coal and timber and grain. Taking these considerations into account Hull deserves still to be accounted the third port of the United Kingdom. Now let us see what the character of this trade is.

The port resembles London in the very general nature of the cargoes carried, in the excess of the imports over exports, in the large proportion which foodstuffs bear to the total value of its trade, and in the very extensive off-loading into lighters.

IMPORTS IN £ MILLS. 1921

| | Hull | Manchester | London | Liverpool |
|---|---|---|---|---|
| Wheat | 10·6 | 6·2 | 17 1 | 13·1 |
| Oil Seed | 9·9 | 0·26 | 5·5 | 5·25 |
| Meat | 3·9 | 2·2 | 58·0 | 40·0 |
| Butter | 2·2 | 0·2 | 1·8 | 21·0 |
| Wool (Raw) | 5·2 | 0·7 | 6·1 | 23·4 |

A wool market is now successfully established at Hull and we may note that in the year considered Hull imported nearly a quarter as much as London. This is a *greatly* increased proportion as up to 1920 the international wool market at London attracted almost all the import in spite of the fact that most of the manufacture is in the West Riding. In 1922, 130 steamers brought 220 mill. lbs. of wool to Hull—chiefly from Australasia.

In this connection we must remember that London still remains the chief wool market of Europe, whereas direct import to Hull or Goole is usually only in cases where the material is actually bought by agents in Australia. This practice is growing both in the English and Continental industry, and with the requisite shipping facilities we may look for increasing import at Hull. A considerable quantity of wool is brought to Hull *coast-wise* from London. This does not appear, of course, in the Hull import figures.

The very extensive trade in butter, bacon and foodstuffs generally, is carried on almost entirely with the near Continental ports, and the smaller steamers concerned in this trade use chiefly the crescent of older docks. We should note that in the case of oil-seed, wheat and timber we are dealing with quantities comparable to those imported at London and Liverpool; indeed in the case of oil-seed the import is second only to that of Marseilles. The huge timber import is mainly a result of the connections of the port with the great coalfield, and the import of the pit props is little less than that at Cardiff or Hartlepool. The import of wheat and of oil-seed is related to the inland navigation which has been so constant a factor in the progress of the port.

We should remember that when little grain was imported and transport facilities were wanting, locally-grown grain was milled at a vast number of water and wind mills scattered all over the land. More recently we have subsisted very largely upon imported grain which has come overseas in large vessels to our bigger ports. Now a big port is of necessity a good distributing centre, and further it must be a place where coal and therefore power is readily available. It is obviously more economical to distribute the flour from a comparatively few great power mills, than to distribute the imported grain to an enormous number of small mills, and thence the flour to the consumers. Thus it is that the industry is almost entirely localised at the huge mills of a few great ports, or at good distributing centres in water communication with such ports. In the case of Hull the wheat is imported as shown in the following table for 1913 (to show normal pre-war conditions) :—

| | | |
|---|---|---|
| America | 1·6 | Mills. of qrs. |
| Karachi | 1·7 | |
| Russia | ·5 | |
| Australia | ·35 | |
| Calcutta | ·13 | |

It is brought into the deep-water docks, and thence off-loaded into the lighters which infest all Hull docks, and remind one of the dependence which the port still has upon its waterway connections.* The lighters take much of the grain from the docks to the great mills situated on the river Hull itself, which, though no longer the harbour proper, is crowded with barges and has both banks fully occupied for nearly two miles with flour mills, seed-crushing mills and warehouses. Very large quantities are water-borne to the mills at Selby and York. Indeed, grain and coal are the only two important traffics on the Ouse river, navigation of which is rendered unsatisfactory by shifting banks above Goole.

Mills at Tadcaster, Wakefield, Leeds and Gainsborough receive considerable supplies by water, and the railway sendings are comparatively small. Oil-seed is in much the same case, though this commodity is not so widely distributed as in the case of wheat. The seed is sent by lighters from the deep-water docks to crushing mills on Hull side, or by water to the huge mill, probably the largest of its kind in the world, at Selby. The resulting cattle-food cake, fertiliser and oil are widely distributed both by water and rail.

As another instance of the localising of an industry resulting from modern conditions, we may take the fish trade. The majority of Hull trawlers are big vessels, often absent for three weeks at a time, and requiring therefore large stocks of coal and ice, for the fish trade of this port is mostly concerned with the distant grounds of Iceland and the White Sea.* The modern industry requires facilities for the provision of these stocks and for the repair of trawlers, and, most important of all, for the rapid distribution of the catch. Such facilities will usually only exist at a big port and the modern industry is increasingly centred at such, and is dwindling at the older fishing settlements, which could not supply such conveniences. The St. Andrews docks are entirely given over to this traffic, and are fully equipped with railways sidings, fish quays, coal hoists, ice factories, repairing slips, fish-refuse works, and a box-making factory. Huge as is the figure for the Hull catch as given in the official publications, it really underestimates the interest of the port in the trade, for it neglects the great import by fast steamer of loosely-packed herring from Norwegian Fiords. The curing of these at Hull is an industry in itself.

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* In many cases the very building of the docks was conditional upon lighters being guaranteed a toll-free admission.

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* Really the *entrance* to the White Sea, i.e. the Barentz Sea. Hull trawlers visited these grounds first in 1906, and the valuable catches of *plaice* encouraged extensive fishing here. This reached a maximum in 1911, but there was a serious falling off in the next three years, and fewer boats visited the ground in 1912 and 1913, for a catch of less valuable fish hardly pays for the voyage.

It neglects also the great quantity of fish caught in the North Sea by trawlers equipped and manned by Hull. The whole of this catch is taken by fast carriers to Billingsgate and is the only fish water-borne to that market, though enormous quantities arrive by train. This is a branch of the trade quite peculiar to Hull.

Not more than a bare reference need be made to the larger geographical factors which influence our fishing industry. The shallow waters of the West European continental shelf with its off-shooting ridge through the Faroes and Iceland, have been fishing grounds throughout history, but they were accessible from all British ports, though some obvious advantages lie with the East-coast stations. We are more concerned to point out that the equipment and resources of Hull as a great general port have enabled it, with a very few other suitably equipped and situated stations, to attract the greater part of the enormously increased catch of recent years; an increase which must be related to the use of the trawl, to the use of power on trawlers and drifters, and at least as much to increased facilities for rapid distribution.

The distant fishing so characteristic of Hull is nothing new to the port. Centuries ago Hull boats visited these grounds and took the salted products to the Catholic countries of Southern Europe. This branch of the industry is represented to-day. On the flats west of St. Andrews dock one may see—in suitable weather—large quantities of heavily-salted cod being dried for export, mainly to Mediterranean ports.

In competition with the increasing efficiency of continental stations we may notice a very recent tendency for our trawlers to land their catches direct at continental ports, and our general supremacy in the traffic is evidenced by the great proportion (about three-eighths) of our total catch, which is exported (most of it herring pickled in barrels, or "Klondyked," i.e., loosely packed in salt and ice) to the Baltic and near continental ports.*

Hull is not pre-eminently a centre of herring fisheries, as are the Scotch stations, and Yarmouth and Lowestoft, the greater portions of the catches of which were salted or cured and exported. Nevertheless the herring catch is big (about one-eighth of the total).

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* This was the case immediately before the war. A large proportion of the sendings were to Germany.

The greater number of trawlers engaged in East-coast fisheries are not built at Hull, where the valuable space devoted to shipyards is used in the construction of larger boats, but at the river-side yards of Beverley, Goole and Selby, where no other class of boat is built.

The most recent important development of Hull is connected with its coal shipment traffic. Hull has not the historic connection with coal export exhibited by ports (notably Tyneside) which are situated practically on coal-fields, and its importance in this direction is rather to be related to the quite recent extensive eastward development of the Yorkshire, Derby and Notts. coal-field.

Over 150 pits send coal to Hull for export, 30 of them in large quantities (over 20,000 tons), and actually one-half is forwarded by a dozen of the latest and largest pits in the Doncaster area.

The waterways (Aire and Calder and South

Yorkshire) send a large quantity but take little part in the big increase of recent years, e.g. :—

| In mills. of tons | Via River | Via Railway |
|---|---|---|
| 1902 | ·61 | 2·56 |
| 1907 | ·68 | 5·8 |
| 1912 | ·46 | 6·5 |
| 1922 | ·22 | 5·4 |

Foreign countries immediately before the war received coal from Hull, as shown in the following table, and as might be expected (particularly in Germany), the coal was very generally for use near the foreign receiving port. Only a small portion was carried inland, and that usually by water.

Coal export in mills. of tons :—

| | 1913 | 1922 | | 1913 | 1922 |
|---|---|---|---|---|---|
| Russia | ·99 | — | S. America | ·25 | ·12 |
| Germany | ·58 | ·69 | Italy | ·22 | ·03 |
| Holland | ·42 | ·47 | Egypt | ·22 | ·04 |
| Sweden | ·31 | ·30 | France | ·21 | ·59 |

Of the quantity sent from Hull in 1912, six-ninths was exported, two-ninths was sent coast-wise, and one-ninth was bunker.

The docks, particularly the Alexandra, William Wright and New Joint, have all up-to-date coal-shipping appliances, special attention being given to the prevention of coal breakage.

Competition for coal export from the Yorkshire, Derby and Notts. coal-field exists at

Goole, Grimsby and Immingham. Thus for 1913:—

| In $10^6$ tons | Export | Coast-wise | |
|---|---|---|---|
| Hull | 4·6 | 1·0 | 5·6 |
| Goole* | 1·3 | 1·4 | 2·7 |
| Immingham | 1·8 | ·14 | 1·94 |
| Grimsby | 1·2 | 0·3 | 1·23 |

The building of a great deep-water dock at Immingham quite especially equipped for dealing with coal as well as with general commodities was viewed with some apprehension by those with interests at Hull. The newer harbour undoubtedly has a shorter lead to the more easterly portion of the coal-field, and the export there is rapidly developing, but as yet Hull figures have not been adversely affected.

In closing this brief review of the growth and present activities of the port of Hull, it is advisable to recapitulate the outstanding stages of development.

*Firstly.*—We saw the tiny marsh-surrounded settlement existing only because of the shelter offered by the little creek of the river Hull. At this stage, and for the requirements of the time, the situation was obviously inferior to that of such up-river ports as Gainsborough or York, and even to that of its older neighbour Beverley.

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* Most of this comes by main Aire and Calder canal to Goole and is the chief traffic of the canal. It is borne in trains of rectangular steel-compartment boats, locally known as "Tom Puddings." These are hoisted bodily out of the water and overturned, through a spout, into the hold of the collier.

*Secondly.*—Very early the advantage of deep water, consequent upon a position near the estuary mouth, more than compensated for the disadvantages of distance from the more populous areas, and Hull became a point of transhipment for river craft trading with towns on the navigable portions of the Ouse and Trent basins. In the period immediately preceding extensive canal construction, i.e., in the first quarter of the eighteenth century, it is noticeable that difficulties of road transport deflected to the Trent, Ouse and Hull water route much traffic from North-Central England which would have gained London more directly by an overland route.

*Thirdly.*—A network of canals, of which the Aire and Calder was and is the most important brought the industrial West Riding into water communication with Hull.

*Fourthly.*—The advent of deep-water ports and docks consequent upon the increasing size of carriers did not affect Hull adversely, for the port is situated at the most marked concavity of the estuary, and has natural deep water. The immediate surroundings of the city too were such that the engineering of at any rate the earliest docks was not a very difficult problem. Railways amplified and emphasised the lines of communication already existing, and then were instrumental in widening the hinterland of the port.

*In the modern port we noted* :—

(*a*) The effect of an industrial hinterland on the prevailing classes of traffic—the great import of foodstuffs and export of manufactured articles.

(*b*) The very considerable part which some of the waterways take in the trade of the port to-day, particularly in the cases of wheat, oil-seed, and coal.

(*c*) The influence of the port *qua* port in localising there great milling and fishing industries.

(*d*) The extension of the South Yorkshire coal-field, which has caused the Humber to become an exporting area comparable in point of quantity exported to that of Tyneside or South Wales. Of this Humber shipment more than half is dealt with at Hull.

# CHAPTER VI

## THE NORTH STAFFORDSHIRE COAL-FIELDS AND THE POTTERIES

THE river Trent, before entering its northern course through the Humber plain, has skirted the Southern Pennines, and actually takes its rise in the extreme south-western margin of those hills. Here, from its source to the town of Stone (12 miles) it flows in a clearly defined depression, shut out from the Cheshire plain to the west by an echelon of hill ridges, 500 to 600 feet in height (Fig. 18). The northern half of this depression is occupied by several small converging valley streams, the head waters of the Trent itself, and here lie clustered the towns of the Potteries. They have outgrown their valley sites and meet over the low divides to form practically one large town.

The identification of certain areas with definite industries is here so marked that the locality has acquired the name of the industry, and the segregation of towns is known as the

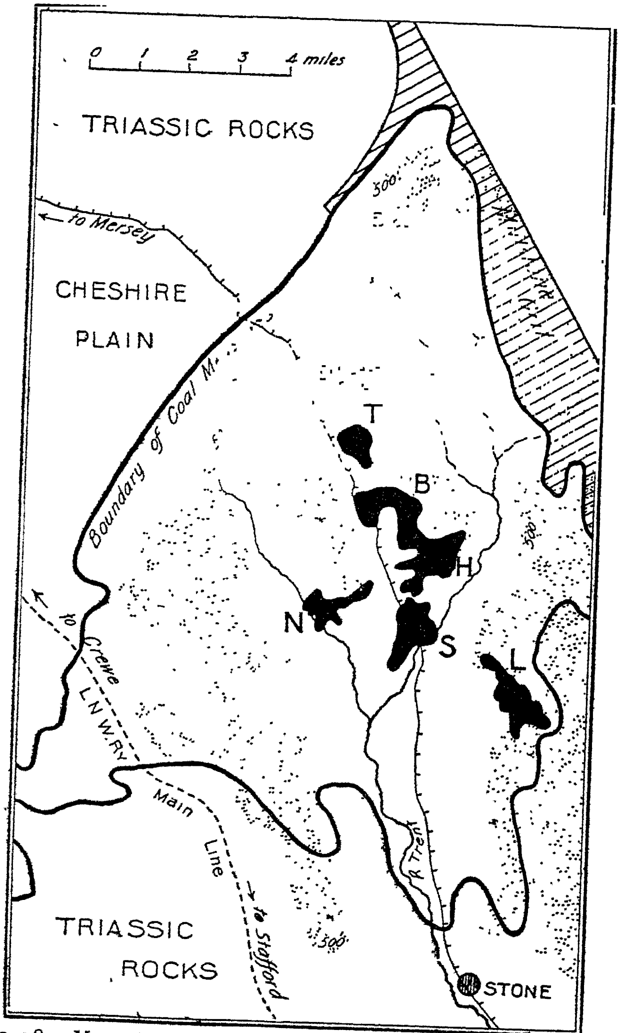

FIG. 18.—Map of N. Staffordshire Pottery area, land over 500' ·:·:. N. Newcastle-under-Lyme. S. Stoke, H. Hanley, B. Burslem, T. Tunstall, L. Longton. Coal Measures ○ Canal

Potteries wherever English is spoken, and in many places where it is not. Yet the making of pots is not the only form of industrial activity, and it has not always been the most important. Coal mining and iron manufacture employ nearly as many people, and have an earlier recorded history.

The Pottery towns are at about the centre of the outcrop of the North Staffordshire coal measures, which are exposed here in a roughly triangular area of about 100 square miles. They are flanked by the older Pennine carboniferous rocks on the north and east, so extension cannot be looked for in these directions (Fig. 18).

The western boundary is formed by a great fault (700 feet throw), and beyond this, the coal measures are depressed under a cover of Triassic rocks. To the south the measures dip beneath these newer formations, and here the well-wooded, fertile, undulating country is in strong contrast to the bare slopes and grit edges of the coal-field to the north.

Structurally, the measures are exposed in a double fold—a narrow, steep, faulted anticline on the west—represented in surface relief by the ridges which separate the Trent valley from the Cheshire plain—and a broad, shallow syncline in the east—containing the Trent head-waters and the Pottery towns. The axes of these folds converge and rise towards the northern limit of the outcrop. Further folding to the east has exposed the Millstone Grit, and separates the main field from the unimportant little coal basins of Shaffalong and Cheadle.

The minor elements of relief are the result of differential weathering, the resistant grits standing up in narrow ridges between parallel valleys of clay and shale and all converging towards the apex of the field in sympathy with the structural folding. From this apex, too, radiate a number of faults which, by depressing the productive measures to a great depth under relatively barren series in some places, and in others bringing these same productive measures near to the surface, have done much to determine the areas of actual coal mining.

Thus, the old market town of Newcastle is set on a wedge-shaped faulted block, where the productive measures are depressed to lower levels than is the case either in the mining areas of Stoke to the east or of Silverdale to the west. It is now a sort of residential suburb of the Pottery towns. In earlier days, unindustrialised itself, it opposed the construction of the canal which rescued them from extinction, and fifty years later was instrumental in deflecting the main railway five miles to the west of them, thus perpetuating to some extent the quality of isolation which limited their early development.

The coal is mined on the flanks of the western anticline, and, to a greater extent, around the broad syncline to the east. Much coal at a moderate depth remains here, and it will probably be long before there are extensive workings in the deep concealed measures to the west and south. Most of the output is used locally.

There are records of early coal mining, though the governing fact in this field was its comparative isolation. The coals were used only locally, and there was little mining activity until the end of the seventeenth century.

As in most other coal-fields, too, iron ore occurs in the coal measures themselves, but with the advantage that here, as in Lanarkshire, it is sometimes associated actually with the coal in blackband seams of considerable thickness.

To-day, North Staffordshire and Lanarkshire are the only two coal-fields with any considerable production of coal measure ore.

*The Potteries.*—There are no special records of pottery work here before 1600.

We must remember that the making of rough earthenware was a typical domestic industry, possible in all places where there were clay and brushwood for firing, and consequently very widely scattered. In the seventeenth century coal was used for firing. But all our coal-fields have belts of clay which would be suitable, at any rate, for rough earthenware (e.g. the seat earths used in the big earthenware industry at Scotswood-on-Tyne), and it is not easy to determine precisely the factors which in the eighteenth and nineteenth centuries so definitely localised the industry here.

We should remember, however, that the area was a rather poor agricultural district, with some iron industry, it is true, but limited by the lack of natural transport ways.

Mr. J. C. Wedgwood, in his History of the Potteries, points out that around Burslem the land was split up among a great number of copyhold owners, and that shortly after 1600 the copyholds were enfranchised. There were no demesne lands, and the people were independent of the big farmers and large landowners. They had a security of tenure, which was a stimulus to initiative. Coal and clay were at hand and lead for powder glazing was obtainable at Lawton Park, six miles to the north, in the Carboniferous Limestone. The Pottery towns themselves are not situated on the outcrop of the main coal seams, but extend in an almost " continuous line along an outcrop of quick-burning coals,clays,and marls."*

The distances involved were so small that transport difficulties at first were serious only in connection with the marketing of their wares. The industry was carried on as a subsidiary one to agriculture, and there soon grew up a supply of independent skilled workers in the district.

" All these master potters were handy men of many trades. They made their pots in sheds at the backsides of their dwelling-houses —alongside the cowshed. They dug their own clay—often in front of their own front doors. The Wedgwoods at least owned and dug their own coal wherewith to fire the ovens. It was a peasant industry carried on by the family among the pigs and fowls ; and when they were not making show pieces for presentation, they made butter pots in which farmers might market their butter at Uttoxeter."*

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* " The Geology of the N. Staffordshire Coal-field," by Walcot Gibson, B.Sc., F.G.S., 1905, p. 3. *Memoirs of Geol. Survey.*

The inventions, the skill, and the foresight of a few men also had much to do with the pre-eminence to which the industry had attained by the mid-eighteenth century.

The invention of salt glazing (which temporarily took the place of lead glazing in the eighteenth century until the lead glaze was applied in liquid form), the use of moulds, and a general improvement in the colour and consistency of the clays used, marked the work of the eighteenth century.

Special clays from Dorset, Devon, and (in 1770) from Cornwall, together with flints, all began to be imported into the area in this century. These imports changed the whole character of the industry. The district became noted for its chinaware, and the local marls were used only for heavy earthenware, saggars and fire-bricks.

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*Staffordshire Pottery and its History, by J. G. Wedgwood p. 13.

It is to the advantage of Staffordshire that the kaolin of Cornwall is near the sea, but not near any coal-field. Nevertheless, the circuitous route, and particularly the long overland pack-horse journey, at first from Chester and later from the Mersey, rendered the position of the industry critical until the opening of the Trent and Mersey canal in 1770. Wedgwood was untiring in his efforts to lessen the effective distance between the Potteries and their raw materials and markets. With others he framed the petition to Parliament for authority to build the canal. It contains this significant passage* :—

"In Burslem and its neighbourhood are near five hundred separate potteries for making various kinds of stone and earthenware which find constant employment and support for near 7,000 people.

"The ware of these potteries is exported in large quantities from London, Bristol and Liverpool, Hull, etc., to our several colonies in America and the West Indies, as well as to almost every part of Europe. Great quantities of flint stones are used in making some of the ware, which are brought by sea from various parts of the coast to Liverpool and Hull: and clay for making the white ware is brought from Devonshire and Cornwall, chiefly to Liverpool, the materials from whence are brought by water up the river Mersey and Weaver to Winsford in Cheshire; those from Hull up the Trent to Willington; and from Winsford and Willington the whole are brought by land carriage to Burslem. The wares when made are conveyed to Liverpool and Hull in the same manner."

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* Quoted in *Staffordshire Potteries and Its History*, by J. C Wedgwood, p. 91.

Wedgwood, and those associated with him in this petition, saw clearly that the industry could not continue to flourish under these conditions, and their enterprise was rewarded by the opening of the Trent and Mersey canal in 1770. By this date Brindley had completed the very successful Bridgewater canal. This Trent connection was a greater challenge to his ingenuity.

Runcorn on the Mersey estuary (where it is connected with the Bridgewater canal) was accessible to the sailing vessels bringing the clay and flints from the South coast. From this point the canal crosses the Cheshire plain and passes the western hill barrier of the Potteries by the Harecastle tunnel (Fig. 18).

After traversing the pottery area it follows the course of the River Trent, which it finally joins at Shadlow, ten miles above Nottingham. It is ninety-three miles long, four and a half feet deep, and has seventy-five locks. Thus were Hull and Liverpool connected with the Potteries. Freight charges were effectively reduced, and the industry much stimulated.

The Trent and Mersey traffic did not keep pace with the development of the industry in railway days, but it is still responsible for a large proportion of the assemblage of the raw material, though not now for the distribution of the ware to markets. The canal is one of the few of any real economic importance to-day.

In considering the continued importance of the industry under modern conditions, when so few of the requirements are locally obtained, we must remember that the bulkiest of these is coal itself, and that the southern china clays are not themselves situated within very easy reach of any coal-field.

We have noticed that North Staffordshire and Lanarkshire are the only districts in Great Britain where coal measure iron ores are still being raised in at all considerable quantities, and that North Staffordshire has had a long connection with the iron industry. The ore occurs in part as a blackband seam so associated with carbonaceous matter that it may be calcined without the further addition of fuel. Much of the best seams has been worked, and it is unlikely that the output will increase. Some ordinary clay band coal measure ore is a bye-product of some of the mines, but it is the distance from the sea, and the presence of the blackband seams which have rendered the use of coal measure ores economic. The district uses more ore than it produces, the surplus being brought largely from Northamptonshire and mixed with the local ores.

# CHAPTER VII

## THE SOUTH LANCASHIRE INDUSTRIAL AREA

FIG. 19 indicates that this area forms essentially the northern portion of a basin in which the coal measures have survived the denudation which has stripped them from the Clitheroe and Pennine uplifts to the north and east respectively.

Yet within this basin the lesser Rossendale anticline has been denuded of coal measures, and stands a rugged moorland of Millstone Grit completely surrounded by the measures, and separating the productive Burnley field from that of South Lancashire proper. The Permian and Triassic rocks of the West coast and Cheshire plain rest unconformably on the denuded coal measures.

The definite limits of the coal measures then are formed by the outcrops of Millstone Grit in the north and east and around the Rossendale inlier of that rock. To the west and south the measures are overlain by newer

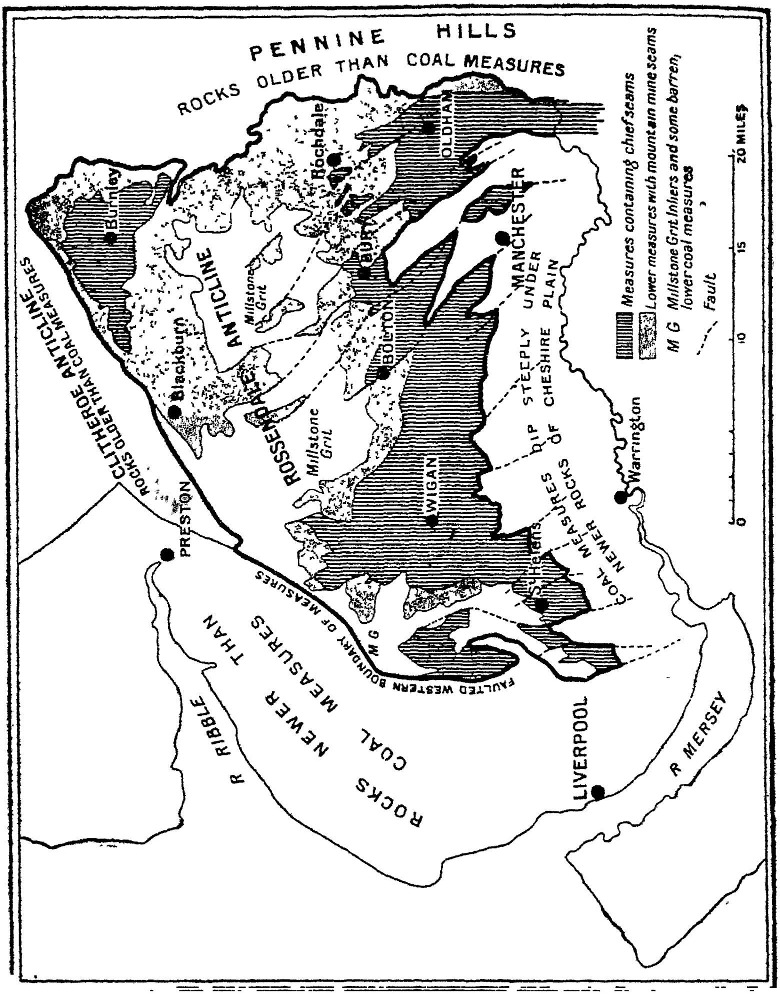
PENNINE HILLS
ROCKS OLDER THAN COAL MEASURES
OLDHAM
Rochdale
Burnley
MANCHESTER
BURY
Millstone Grit
ANTICLINE
BOLTON
Blackburn
ROSSENDALE
Millstone Grit
CLITHEROE ANTICLINE
ROCKS OLDER THAN COAL MEASURES
DIP STEEPLY UNDER CHESHIRE PLAIN
WIGAN
Warrington
PRESTON
St Helens
ROCKS OF NEWER COAL MEASURES
FAULTED WESTERN BOUNDARY OF MEASURES
M G
ROCKS NEWER THAN COAL MEASURES
R RIBBLE
LIVERPOOL
R MERSEY
Measures containing chief seams
Lower measures with mountain mine seams
M G Millstone Grit Inliers and some barren lower coal measures
Fault
0
5
10
15
20 MILES

FIG. 19—The South Lancashire Coal-field.

Note the Rossendale Anticline separating the productive middle measures about Burnley from those of St. Helens, Wigan, Bolton and Oldham. The newest and largest collieries occur towards the southern limits of the field.

material. They do not, however, gradually dip under these newer rocks as do the Durham coal measures beneath the Magnesian Limestone to seawards.

The actual boundary of the exposed coal measures in the west is formed by a very extensive fault with a throw of over a thousand yards. So, too, the jagged outline of the southern boundary is due to a number of north-west to south-east faults, which have divided the coal measures into a series of blocks. Thus, the coal seams worked near the surface on one side of such a fault may be found only at great depth on the other side; or, if the displacement be in the opposite direction, they may be entirely absent through denudation on the other side.

The upper measures are characterised by a number of thin seams of coal, and are only exposed in a small faulted block just to the south of Manchester. Elsewhere the exposed coal-field has been stripped of its upper measures, though these have been proved in some borings beneath the Triassic covering. The middle measures contain the greatest number of workable seams, and form the most productive portion of the coal-field.

A greater or less thickness of them (according to the amount of denudation) forms the main portion of the coal-field south and west of the Rossendale Upland. They have been preserved too in a synclinal trough in what is known as the Burnley coal-field, lying between the Rossendale and Clitheroe anticlines.

The remainder of the exposed field consists of the lower measures. These are relatively barren, though some thin seams are worked (chiefly by adit and shallow pit) where these measures out-crop in the hilly country adjoining the Millstone Grits of the Pennines and Rossendale. These "mountain mines," as the two workable seams are called, are worked only for local use. However, they approach each other and ultimately coalesce in the portion of the lower coal measures which underlies and outcrops around the Burnley middle measures, and here form a valuable seam which has been little worked as yet.

Now, as to the economic aspects of these structural conditions. We should first notice that the great fault which forms the western boundary of the exposed measures cuts them off at all points from tidal water. This was quite enough before modern modes of transport to characterise this as an inland field. Thus the first considerable waterway improvement in Lancashire was the canalising of the little Sankey brook, so that coal from the neighbourhood of St. Helens could reach the navigable Mersey estuary, and so Liverpool.

Coal was actually sent from the neighbourhood of St. Helens by the Sankey Canal, the Mersey estuary, and thence by sea to Preston, before the canalising of the river Douglas gave directer access from the coal-field to the Ribble estuary.

These are comments on the difficulty of early road transport. The district has not the historic or present connections with coal shipment that characterise the North-Eastern and Cumberland fields.

Then the great faults have divided the field up into regions of very varying productivity. Considerable areas of the coal-field where denudation has left only the lower measures are relatively barren. The densest manufacturing areas occur north and south of Rossendale and some distance from the sea.

Thirdly the dip of the strata, especially in the hilly country bordering the Pennine uplift, and again where the measures dip under the Triassic rocks to the south, adds to the difficulties of mining, and to the depth and expense of workings. Some of the deepest workings in the kingdom are in South Lancashire. Also, one may state generally that in dipping towards the Mersey the coal seams become thinner, contain more waste matter and are separated by increasing thicknesses of barren measures.

The coal-field in recent years has produced about ten per cent. of the United Kingdom output, and a larger proportion of the output is used locally for factories and domestic purposes than is the case in any other of our chief coal-fields.

*General Geographical Position.*—Between the Ribble and the Dee the hilly difficult country, typical of so much of our Western coasts, gives way to the considerable lowland of South Lancashire and Cheshire.

Three estuaries of great tidal range cross this plain to the sea.

Almost as important as this access to the sea is the extension of the plain of Cheshire to the south-east in the low, broad passage-way of gentle relief between the Southern Pennines and the Welsh mountains. Here approach the upper waters of the Dee and the Severn, the Trent and the Mersey, and early in the canal era connections were made between these navigable ways. South Lancashire then was open to the sea, to the Bristol Channel, and to the Humber, and no serious difficulties of relief hindered connections with the Midlands and London.

To the North and East were greater difficulties. The Mid-Pennines were effective in increasing the rainfall, and so providing many stream valleys of high gradient, which were the nurseries of the modern textile industries, but they also made communication between the York and Lancashire plains relatively difficult.

However, the rapid growth of the industries on either side, their extension with the use of water power far up almost to the sources of the little moorland tributaries, the differentiation of products, and the possibility of connecting a westward facing with an eastward facing port, all these were factors in the development of Trans-Pennine canals and railways. The Pennines of the headwaters of the Aire, Ribble and Irwell provide more and easier cross-routes than could be found either farther to the north or to the south.

Presupposing that Leeds, Sheffield, Manchester and Liverpool were already centres of some importance, the topography is such that the actual routes could hardly be otherwise than as they are, and we will defer any account of them till after a consideration of the main industry of the district, merely stating here that five railways and three canals cross the Pennines between Lancashire and Yorkshire.

*The Cotton Industry.*—Cotton manufacture is not merely the greatest of our industries—it is the most complex of them all. In nothing is it simple save in its unique centralisation. In an irregular quadrilateral area of roughly 30 by 25 miles, bounded in the main by lines through Preston, Leigh, Stockport and Colne, there are ninety per cent. of the cotton operatives of Great Britain And yet within this little space how much specialisation there is. At one town the operatives are almost all engaged in fine spinning, at another in the production of a particular kind of cloth, while in a third, perhaps, all are busy with bleaching and printing process. Emphatically this is not an industry in which one factory is usually responsible for the work from the initial to the final stages.

Not till the late sixteenth century is there clear evidence of the manufacture of cotton in Lancashire, the " cottons " of an earlier date being in reality rough woollen goods.

Flemish weavers were undoubtedly engaged in the industry at Manchester in the early seventeenth century and the manufacture in England probably owed its initiation to such immigrants. We shall see that geographically Lancashire offered unexampled opportunities for the development of the cotton industry; such as would have almost certainly centralised it there in later times, even supposing that as a cottage industry it had ever been widely distributed throughout the country. As a matter of fact, little cotton work was ever done in any other part of England, and early workers were perhaps attracted to Manchester, in the first place not because of any prescience of the opportunities the district was to offer, but because already considerable organisation of the woollen and linen industries existed there, and moreover the town exercised no harassing regulations detrimental either to the new industry or to the foreigners engaged therein.

Down to the time of the English spinning inventions, European manufacture was only producing a rough product, the warps of which were commonly of linen or of wool. In England and in Europe generally the fine goods and muslins were imported from the East. Raw cotton was derived from the Eastern Mediterranean; and Cyprus and Turkey were relatively large exporters. Some of this crop followed the sea route to Flanders and North Germany; other portions took the chief overland routes. Manufacture was established at ports or at route towns, (e.g Augsburg) already pre-eminent as marketing and distributing centres.

Cotton was brought as part cargo in vessels regularly trading with London, which remained our chief cotton port and market until nearly the end of the eighteenth century when it was surpassed by Liverpool, with its increasing West Indian trade.

Cotton was hardly cultivated, much less exported, from America till after the Revolution (1783), but a few years later the success of the Sea Island variety, cultivated on the coast of Georgia, led to cotton growing in the interior, and by 1795, regular export to the British Isles was established, and Liverpool became the premier cotton port. The import figures given below demonstrate at a glance the enormous industrial development of this period.

| | In mills of lbs. | |
|---|---|---|
| 1788 | 22·6 | ($\frac{2}{3}$ West Indian, $\frac{1}{3}$ Mediterranean) |
| 1791-5 (av.) | 26·0 | West Indian and American |
| 1831-5 (av.) | 313·0 | Chiefly American |

This great development points to a rapidly expanding market. The printed cottons, quickly gaining in popularity, and ever more cheaply produced as inventions multiplied, partly displaced, and to a greater extent supplemented, the use of other materials. Moreover as the most important improvements in manufacture originated in England, an export trade to the Continent and to our colonies was soon established, and rapidly increased.

The history of South Lancashire during the last few decades of the eighteenth century and the first few of the nineteenth exemplifies all that we mean by the term industrial revolution. The great inventions which, while increasing the complexity and expense of textile machinery, increased also its productiveness, and rendered accessible new sources of power; the change from domestic to factory conditions; the extension of transport facilities—canal, road and rail; all were concerned in making possible that rapid and cheap production which was to satisfy the growing individual wants of an increasing body of consumers.

It would be out of place to consider in any detail those inventions which, first rendered practible in England and in the cotton industry, spread in one form or another to all textile industries in all countries. It will be alone germane to our purpose to notice the changes in the geographical distribution of the industry, in part, at any rate, consequent upon these inventions.

With regard to the raw material; we may notice that the American import, consisting originally of very ill-picked and dirty cotton, was enormously stimulated by Eli Whitney's invention of the cotton gin (1792). Revolving toothed cylinders forced the pickings through wire ribs, thus trapping the seed from the lint and enabling a slave to clean 300 lb. a day instead of 30 lb.

Till about 1770 the spinning-wheel was the sole producer of yarn, and one weaver could keep several spinners at work and indeed often found it difficult to obtain his supplies ; but the spinning jenny of Hargreaves (1767) made it possible to spin many threads at once, and so increased the yarn output that the difficulty was overcome. Hargreave's jenny really embodied no new principles ; it simply, as it were, multiplied the output of the old spinning wheel.

A little later an entirely novel idea, and one applied to many stages of modern spinning, was rendered practicable by Arkwright. In this, the pulling effected by hand in the spinning-wheel, was now brought about by passing the roving through two sets of rollers, one of which revolved at a higher speed than the other. This was a much heavier and more complicated machine than the jenny, and required power for its use. Arkwright's first mill at Nottingham was horse driven, but in 1771 he erected at Cromford, among the Derbyshire hills, a mill which was driven by water power. Crompton's mule which combined the characteristics of the jenny and of the roller-spinning (water) frame appeared in 1789.

The initiation of roller-spinning had three far-reaching results. In the first place, these machines produced a hard and strong yarn which could be used as a warp, and thus rendered unnecessary the linen and woollen yarns previously required.

Secondly, the machinery was complicated, expensive, and before the advent of steam wholly dependent upon water power, and spinning by this process was of necessity a factory industry.

Thirdly, the mills using the water frame, as it was called, were necessarily situated in stream valleys of considerable gradient, and cotton spinning, so long associated with weaving as a cottage industry in the towns and villages of South Lancashire, was attracted to the Pennine valleys or to the streams emerging to the north and south of the Rossendale upland. The collecting and distributing centres remained the towns, but the actual spinning mills were strung along the streams and were working day and night as a set off against the times, not very infrequent, when an insufficiency of water stopped work altogether.

Weaving remained a cottage industry long after spinning had centralised in factories, but even hand looms were becoming more complex and expensive, and it became increasingly difficult for the independent cottage weaver to compete with the weaving shed proprietor, who effected economies by the gathering together of many looms under one roof, and who attracted specialised and skilled labour. Thus the factory system began in weaving before the days of the power loom. On the other hand it was not such an immediate consequence upon new invention as in the case of spinning, and further it involved on the part of the factory worker the loss of a good deal of personal freedom and independence. Thus the elimination of the cottage weaver was a slow process. Indeed for a short period after the chief spinning inventions, and before the power loom had been perfected, the skilled hand-loomer had little to complain of in his circumstances. Yarn was, of course, relatively cheap, and the roller-spun yarn enabled weavers to produce fine cloths in competition with those always previously imported from India. For these, and for cotton goods generally, there was at this period a most rapidly extending market.

The power loom, rendered practicable by Cartwright in 1787, took many years to win its way, but eventually its rapid, even production made it an almost hopeless task for the domestic weaver to compete with the factory. Between 1820-40 great distress had overtaken the remaining hand-loom weavers, and by the latter date the ultimate triumph of the power loom was assured. The power loom was sufficiently late* in date to make use of Watt's steam engine, and from the first nearly all power weaving was steam driven. New concerns, and they were many, found it convenient to use one power agent only and to combine spinning and weaving in the same factory. Thus the effect of steam weaving was to shift the balance of the factory industry from the outlying Pennine hills to the coalfield proper, and to effect a partial, if temporary, re-association of the two main processes, spinning and weaving, which the use of water power for spinning had to some extent separated.

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* The identification, in Lancashire, of the term manufacture with weaving in contradistinction to spinning, is perhaps a relic of the period when spinning was using water power while weaving remained a *hand* industry.

But increasing specialisation brought about another separation in the latter half of the nineteenth century, for yarn and cloth are in a sense finished articles, and each requires its own independent market organisation. Much yarn is exported as such and, further, the average manufacturer (i.e. weaver) has more choice, and takes less risk, in the open yarn market, than would be the case if he depended merely on his own yarn production. The chief spinning centres remained on the coal area immediately around Manchester, while weaving became increasingly important in that part of the coal-field which lies to the north of Rossendale forest.

Our supply of raw cotton is by no means confined to America. Since 1882 the improved Egyptian irrigation systems have rendered possible the large-scale cultivation of such a crop as cotton, which there requires perennial irrigation as contrasted with basin irrigation. The cultivation had been stimulated during the American Civil War, has steadily increased, and is now about one-tenth of the total American production. We normally take about one-half of it, representing some nineteen per cent. of our total import, as against seventy-five per cent. from the United States.*

On the average it is a very high grade, long staple strong cotton, suitable for the finest yarns and comparable to some Sea Island varieties.

India has an even bigger average production, but much is used there, and of the huge export most goes to Japan and (normally) Germany, while little comes to Liverpool. Many qualities are grown, but, again, on the average it is a coarse, short-staple, poor-grade cotton.

In earlier times the cotton was sold on inspection and by auction at Liverpool, but now the spinners wish to be assured of their supply, and buy for delivery at some future date. Modern scientific improvements in the dissemination of news have rendered it possible for skilled buyers and sellers, members of the Liverpool Cotton Exchange, to follow the growth of the cotton crop in all parts of the world. A spell of drought or of frost, a report of boll-weevil ravage,* the amount of cotton in warehouse stock, the present and probable requirements of the great markets ; all these and many other factors the cotton dealers must follow from day to day, and each will influence the price of cotton.

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* In the last few years the U.S.A. have been receiving large quantities of Egyptian cotton—nearly half as much as we ourselves take. This is symptomatic of a tendency to spin higher counts, and also of the dwindling production of the Sea Island variety, for the very highest varieties of which there is a very fluctuating market. Very considerable quantities of Egyptian cotton have recently been grown too in the Salt River irrigation areas of Arizona.

The sold cotton, now the property of the spinning firm, has to journey some distance to the spinning mill, for though cotton mills have been started at the port they have never succeeded there. The most general mode of transport is by rail to the nearest station, and thence to the mill by motor lorry ; but many of the biggest concerns have their own rail sidings. The Leeds and Liverpool Canal still takes some from the port, and recently cotton has been carried a distance of forty and fifty miles from Liverpool by motor lorry direct to the mills. This road competition with the railways, in all stages of the cotton industry, is a recent but very real development, and only wants proper organisation to become still more effective. Since the opening of the Ship Canal, a growing proportion has come direct to Manchester and been there distributed as from Liverpool. About one-fifth of the total import now takes this route.

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* The boll weevil is a small beetle which destroys the cotton boll. It appeared on the Mexico border of Texas in 1892, and since has spread steadily throughout the cotton belt and has recently reached the Florida and Georgia area of Sea-Island production. It cannot be entirely eradicated, but if suitable precautions are taken, good crops can be grown in its presence.

And now our cotton enters the industrial area proper, and before following its route there we may well seek some geographical explanation of the intense centralisation of the industry in this small area.

Fig. 20 marks all the important cotton spinning and weaving towns. Most of them are in South Lancashire, but a few occur just over the county borders in Yorkshire, in Derbyshire, and in Cheshire. What particular advantage does this district offer?

Three are usually quoted: a moist, equable climate, the presence of coal, and a convenient port. Let us analyse these points a little more fully and add to them some others.

First then as to climate. Both in spinning and weaving this is of great importance. The fine filaments become more brittle and more liable to break if there is not sufficient moisture in the air. The ideal climate should be equable—as little as possible subject to extremes either daily or seasonal. The relative humidity (i.e. the amount of water present in

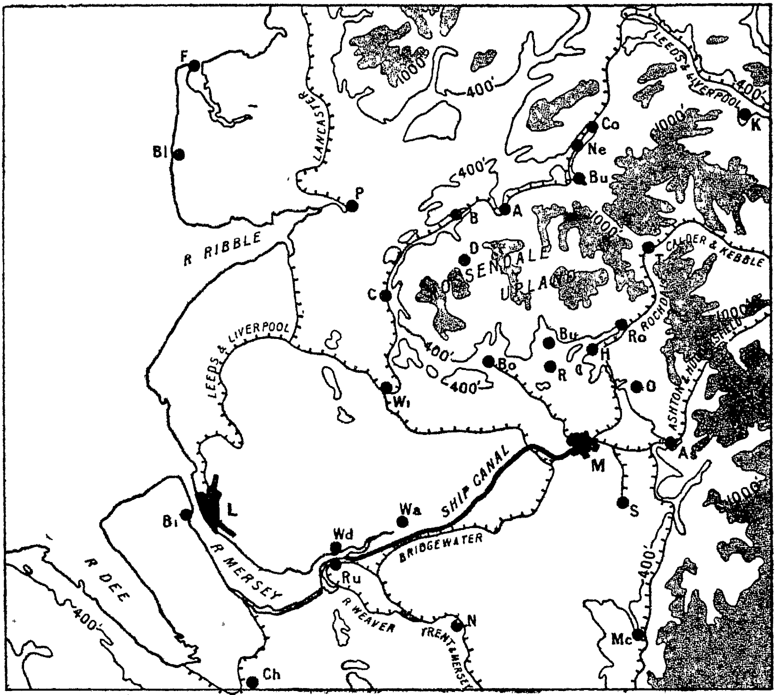

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Fig. 20.—Map of South Lancashire showing Pennine Canal connections in relation to the relief. The cotton-working towns all lie to the north of a line joining Wigan and Stockport.

400′ Contour, ______; Above 1000′ ∴∴; Canals, ⊥⊥⊥⊥

| | |
|---|---|
| A. | Accrington |
| As. | Ashton |
| B. | Blackburn |
| Bi. | Birkenhead |
| Bl. | Blackpool |
| Bo. | Bolton |
| Bu. | Burnley, N<br>Bury, S |
| C. | Chorley |
| Ch | Chester |
| Co. | Colne |
| D. | Darwen |
| F. | Fleetwood |
| H. | Heywood |
| K. | Keighley |
| L. | Liverpool |
| M. | Manchester |
| Mc. | Macclesfield |
| N. | Northwich |
| Ne. | Nelson |
| O. | Oldham |
| P. | Preston |
| R. | Radcliffe |
| Ro | Rochdale |
| Ru. | Runcorn |
| S. | Stockport |
| T. | Todmorden |
| Wa. | Warrington |
| Wd. | Widnes |
| Wi. | Wigan |

the air considered as a percentage of what it would contain if saturated) should be high.

Now the British Isles as a whole have a remarkably equable climate and well-distributed rainfall, and there is no part of them as little suited to cotton manufacture as are some districts abroad where the industry is followed. But even within the British Isles some districts are very definitely more favourable than others. As far as humidity and equability are concerned, probably any of our West* Coast climates down to South Wales are sufficiently suitable ; but there are other considerations. Coal is required, and our only three considerable coal-fields with suitable climates are those of the district immediately south of Glasgow, South Lancashire, and South Wales.

The first of these had much inferior communication with the rest of the country, and the last is of more recent development, and certainly has no advantages over South

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* The *prevailing* air movement over these islands is from the west, i.e., from the Atlantic. The hills of our western coasts standing in the way of this current cause it to rise, with the result that the air, expands, cools, becomes saturated, and parts with some of its moisture in the form of rain. Thus our western counties have heavier rain than occurs farther east, e.g. Bolton has a rainfall nearly double that of Leeds.

Lancashire which would attract textile industries already there established. Then again, the fact that the Mid-Pennine area was already associated with textile work, i.e. wool and linen, was of great benefit to the new industry.

For a short period prior to the perfecting of the steam engine, the Pennine and Rossendale valleys provided water power, and the same water supply has been available in the great subsidiary industries of bleaching, dyeing and calico printing. Lastly Liverpool is not only well situated relative to the Lancashire coalfield, but no single western port could have easier access to all the great British centres of population, and its cotton traffic and general traffic have developed side by side with mutual advantage.

We may safely say that no area in Great Britain offers better facilities for the industry than the one in which it had its birth. The natural advantages have been great—very great, but there have not been wanting men worthy of them. No industrial area has rivalled Lancashire in the invention and improvement of textile machinery. The unequalled skill of her operatives may in a loose sense be said to be hereditary. Generation after generation enter the mills and it is comparatively rare for man or woman to leave the industry for some other type of work.*

And there is now the immensely developed organisation of the industry. Well-established markets and traffic routes, as well as the enormous amount of capital sunk in land, mills, mines, local subsidiary industries and transport facilities—all have grown with the growth of the main industry and are concerned in its stability.

If the cotton whose course we are following is of fine quality and long staple ; if it is, in fact, the best Egyptian or Sea Island variety, then in all probability, it will be required in the Bolton or Manchester districts. Short-staple American or Indian cotton would go to the Oldham, Rochdale or Stockport areas. Spinning is relatively unimportant in the northern part of the area. And so we come up at once against what is a leading characteristic of the Lancashire cotton district—a high degree of local specialisation, and this is both possible and profitable, because the whole area is so small that none of the specialising centres are widely separated, an advantage not shared by the great foreign textile industries. Bolton, Oldham, the Manchester district, Rochdale, Ashton and Leigh are the greatest spinning centres. All are on the coal-field, and at Bolton and Oldham the coal is particularly accessible. In appearance these South Lancashire towns have little to recommend them. There is no evidence of town planning—they have just grown. The whole district is fortunately on the verge of hilly and sometimes quite attractive country. The mills themselves, and especially the modern ones, are very large, wholly unadorned, but as a rule well lit and well ventilated. Even in Lancashire humidifiers have to be used, though the quality of the climate is effective in that it is here comparatively easy to keep the atmosphere at the right degree of temperature and of moisture.

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* Cp. the U S.A. textile labour.

The raw cotton is usually taken first to the top of the building, and anybody visiting a mill for the first time must be struck by the number of processes included in the term spinning. The first two machines are employed in opening, cleaning and mixing the material, so that it may issue a "lap" of homogeneous consistency. Rooms full of machinery are employed thus before it enters the carding machines where the shortest fibre is eliminated and the long combed approximately parallel, and from which it issues a gossamer veil gathered by the final action of the machine into a thick, soft, loose rope. Half an inch in thickness perhaps, and of not the slightest strength, it yet represents the first stage at which the cotton assumes the form of a continuous strand. A whole succession of machines are now concerned in stretching—by roller—in multiplying and stretching again, to give homogeneity; and after some twist has been acquired, the rope of the carding machine emerges much thinner, harder, and more consistent. It is now called "a roving" and is ready for the last and chief stage—the spinning proper. An enormous area is occupied by the self-acting mules, where the roving is drawn out and twisted, and is wound up on the return of the mule carriage.

And all this complex machinery, every calculated, complicated movement, had its counterpart in the simple-looking motions of hand, arm and wheel concerned in the old-time production.

As already suggested, the spun yarn may go to weaving sheds at the same mill or in the same district, but the greater portion of it goes northwards to the weaving towns of Blackburn Burnley, Preston, Nelson and Accrington, to name only the chief of them. Blackburn, Accrington and Burnley are at the opening of the northern valleys leading from the Rossendale upland and have a position comparable to that of Bolton, Bury and Rochdale to the south of that hill mass. Preston is exceptional among cotton towns in being just off the coal-field and in having port facilities. The River Douglas Canal brought it coal in the pre-railway period.

The exchange is effected through the Manchester yarn market, where yarn agents find customers for the spinners. We should remember here that a great deal of yarn is exported as such.

Even in the small section of the coal-field in the north, where lie the weaving centres, there is marked differentiation, and so specialised is much of the manufacture that the weaver accustomed to the work of one town might find it difficult to undertake work in another. "Blackburn and East Lancashire towns largely produce fabrics for the Indian markets, such as shirting, jacconets, mulls, dhooties, etc. Preston is noted for its shirtings, sheetings, longcloths and for fancy cloths. Burnley produces printing cloths. Nelson and Colne make sateens and brocades. Radcliffe is largely engaged on weaving goods from dyed yarns, and Oldham is noted for fustians."* After weaving there are many variants in the course taken by the fabric or " grey cloth " as it is now called. It may be bought at the Manchester cloth market by merchant exporters and shipped, and so leave the country in the grey. Or more usually it undergoes one or all of the three processes, bleaching, dyeing and printing, before reaching the Manchester packing houses to be prepared for home distribution or for export.

These three processes may conveniently be considered together, for they are not infrequently carried on in the same factory and all alike are dependent upon plentiful supplies of pure water. The work is usually done on commission and the industry is one of great importance.

Factories engaged in this work tap the streams of the district in their upper courses ; thus the calico-printing centre is often a small village in almost moorland surroundings and situated on a stream the lower valley of which may be crowded with cotton mills and densely populated. A considerable number of the mills are situated over the border in Derbyshire and West Yorkshire, and in general these processes add at least two to the already large number of journeys which the cotton has to make in its course from the field to the final market. In earlier times bleaching was effected by the action of sunlight on the cloth, which was moistened with alkali and spread on the grass.* The process took six months and the fields around the cotton towns were white with cotton pieces. One imagines that in these days they would gather more soot than sunlight. In a modern print works the cloth has its size removed, is passed over heated rollers to remove the nap and is then prepared for dyeing or for printing, or for both.

Roller printing is a simple process and has not changed essentially for many years. The fabric is passed continuously over a huge cylinder, and revolving in contact with it are a number of small copper cylinders each running in a bath of colour stuff and engraved with that portion of the pattern which is to be represented in that particular colour. In an elaborate design ten to a dozen rollers may be in action.

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* As is some of the Irish linen to-day about Belfast.

A small amount of work is still done by the old hand-block process, but of course it is much slower and more expensive. The designs, however, are more exclusive and the work has a character of its own.

Yarns are often dyed, and warps sometimes printed, before weaving. An interesting operation sometimes carried out at the print works is the mercerising of cotton. The fabric is tightly stretched while soaked in strong alkali and under these conditions assumes a silky finish. The enormous amount of chemical colour stuff used—" drugs " as they are called in the trade—were mostly of German origin; the heavy chemical—alkali, etc.,—of English. Print works employ a relatively small number of men compared with the great spinning and weaving concerns, but among them must be a number of skilled chemists and engravers, and the work is of so varied and constantly changing a nature that much knowledge, initiative and organising ability are required in their management.

The printed fabric's next journey is to the Manchester warehouses and packing houses. Packing in Manchester is a large industry in the hands of specialists who know just what is necessary for each market. The packing houses have often their own saw mills, and quite a fraction of the huge timber import of Manchester is used in this work alone. Through the Manchester cloth merchant to the great wholesale houses and garment factories, or through the shipping agent via Liverpool or Manchester docks to foreign countries; that is the last stage before the product reaches the final retail markets.

We may notice that about eighty per cent. (value) of our cotton manufactures are normally exported, and that India takes nearly thirty-two per cent., China eight per cent., South America eight per cent. and Europe twenty-one per cent. of the total export value.

Our high count yarns are taken by countries with well-developed weaving industries, but which have not sufficient spindles to supply all their looms, e.g., European countries. Our piece goods go to semi-developed markets, such as India, China, South America, Turkey, etc. Japan is a very real manufacturing competitor for the Far East and uses the major portion of India's huge raw cotton export.* Parts of China are likely to suffer rapid industrialisation, but though they may eventually produce all they require, yet for some time to come increasing import may positively lead to increasing demand.

Already in the century which has elapsed since the industralisation of Lancashire, our markets have undergone great change. Fine yarns and specialised fabrics still cross the Continent's tariff barrier in large quantities, but our modern market is most largely with the great populations of tropical and sub-tropical countries. That India should send about one-half of her own raw cotton to Japan and Germany and a few other countries, and use large quantities of fabrics made in Lancashire of United States raw material, appears at first sight to be an arrangement little likely to be either economic or permanent.

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* Japan is now successfully organising the production of higher grade raw cotton in Chosen.

It is, however, just an instance of Lancashire's quite pre-eminent position in the industry; a position based on exceptional natural advantages, on the initiative and skill of her population, and on the inter-relation of the industry with the whole of our export and import trade.

But we must remember that Lancashire specialises increasingly in yarns of the higher counts and therefore with fabrics of a relatively good class. The Indian mills at Bombay, Ahmedabad, Cawnpore and Sholapur use a total weight of cotton which is rather more than half that actually used in Lancashire. The number of spindles employed, however, is very much lower, and the fabrics are comparatively coarse. The amount of fine spinning is increasing in recent years in India, and there is therefore growing up a tendency towards a directer competition.

It remains to make brief mention of some other industries of Lancashire. In most English counties they would seem important enough. Here they are dwarfed by the one great occupation: many of them are subsidiary to it.

Of these the making of textile machinery is most important. Two of the earliest, biggest, and most reputable of such firms are at Oldham. Between them they employ nearly 20,000 men, and their products are known wherever textile machinery is used, for about half the output is exported. It is interesting to note that half of that again goes overseas to the East. This is a real subsidiary industry localised on its largest and most permanent market. Almost any of our coastal coal-fields could supply as easily the requisite fuel, pig-iron, steel and timber used. What they could not supply is an immediate market, and, more important still, the close relationship between machine makers and users, going back through more than a century with much mutual benefit. The best English textile machinery is unsurpassed. It forces itself by sheer quality through hostile tariffs. Germany,* Russia and France are amongst the largest receivers. The greatest single export is to India.

Improvements in the cotton machinery were early adapted to the making of other textiles, and the Lancashire district sends largely to our other textile districts, e.g. to the West Riding. Some of the most highly specialised, complex, and expensive machines, are specially designed to deal with poor materials, or to give a cheap material the look of something better. Spinning mills exist which deal with nothing else but the waste (short) material of the other mills, and machines exist for spinning cotton and wool mixtures, and for spinning in such a way too as to leave the woollen fibre most in evidence.

Though Oldham is the biggest single centre of textile machinery, yet some branch of the work is carried out at very many of the other cotton towns, some of the largest being in the environs of Manchester, Bolton, Accrington, Bury, Blackburn, Burnley and Heywood.

Now the great textile and engineering works, as well as the smaller forges and foundries, of the country, must work from pig-iron. The only blast furnaces now in South Lancashire are at Wigan, at Darwen and at Irlam; the first two on the coal-field, the last, most productive and most recent, on the Ship Canal. All work largely with imported ore. They do not supply all the wants of the district but South Lancashire is easily accessible for Staffordshire, Yorkshire, North Lancashire and Scotch pig-iron—the last two often coming in by sea.

An industry which receives a considerable stimulus from the cotton industry is that of the heavy chemicals—the great alkali and acid manufactures—but these together with some of lesser importance will receive treatment in the section on the Mersey and its inland waterway connections.

*Manchester.*—Manchester has so real a part in every phase of Lancashire industry that its importance in that respect deserves emphasis here. If there were no Lancashire coal-field, no special facilities for a great industry, yet Manchester would still have been in all probability the chief market centre of the district, though, of course, a comparatively unimportant town.

Manchester lies in fairly low ground surrounded by a semi-circle of hills of which it is the centre. Mersey tributaries are radial to this centre, with the double consequence that Manchester was an early route town and a market for the water-using mills of their valleys. It was the natural receiving station for manufactured goods and distributing centre for raw materials. Its position made it the natural marketing centre for the woollen and linen industries of the Western Pennine valleys and the coming of cotton merely accentuated its London connection, and added to its importance as the district grew. Connection with Liverpool became of exceptional importance with the import of American produce, and this was soon developed, for Lancashire holds a unique place in the history of the transport revolution.

The earliest river improvement scheme in the district was to make the Mersey navigable to as near Manchester as possible. Brindley's first canal was to bring coals to Manchester, his second was to connect it with the lower estuary.

The Pennines to the east are here at their narrowest, and the Trans-Pennine canals and railways converge on Manchester. Its old position of valley route centre is emphasised in these days of railway transport.

Finally the Ship Canal has made of it a great port.

A big manufacturing town commonly has its central area of offices, shops, hotels, and places of amusement. The actual factories are on the outskirts or perhaps in surrounding villages. South-East Lancashire is practically one big town with Manchester as its business centre, its shopping centre, its centre of amusement and of much too of its intellectual life. The towns of Lancashire are for the most part situated at the openings of the valleys to the plains. In earlier days they suffered some slight degree of physical isolation, and they retained each of them a considerable amount of local patriotism, of local traditions, yes, and of local dialect. But they had one thing in common. They were units of one great industry of which Manchester was the business and financial head, an industry so great that it gave to the commerce of its capital a world-wide range of influence.

# CHAPTER VIII

## THE LANCASHIRE CANAL SYSTEM

(See Fig. 20, p. 173)

The first Trans-Pennine canal to be begun, though not the first to be completed, was that connecting Leeds and Liverpool, and, therefore (for Leeds soon had connection with the Ouse) Hull and Liverpool.

The Act for this was obtained in 1770, but the through route was not completed until 1916. The undertaking had everything to recommend it. The connection of the American port of Liverpool with the continental port of Hull, of two very different industrial areas, and of these areas again with considerable agricultural districts—here was just the differentiation of production which should result in traffic.

The portion between Liverpool and Wigan, which rounded the Upholland upland in Ormskirk and connected with the river Douglas navigation, was first opened, and soon became important for the carriage of coal to, and of raw cotton from, Liverpool. At Wigan the canal, so far little above sea-level, steps up to the 300 feet contour by a flight of twenty-one locks and continues at about this height to Chorley. Throwing out a branch to Clayton Hill, whence a now derelict tramway connected with Preston, it passes successively through the great weaving towns of Blackburn, Accrington, and Burnley.

It then follows the Ribble and Aire valleys into Yorkshire, and so gets across with the lowest summit level of all the Trans-Pennine canals. The canal in Lancashire is 87 (out of a total of 127) miles long and has forty-five locks. The actual Trans-Pennine is less than four feet deep, and is comparatively little used, but the portion between Blackburn and Liverpool carries much coal (the amount having been fairly constant for forty years) and raw cotton. It is interesting to note that yarn, the main raw material for the weaving towns served by the canal, is seldom carried by it or by canal at all. The Leeds and Liverpool Canal must be regarded as one of the premier canal works of the country. Only recently has it become almost unremunerative.

Coal from collieries adjoining the canal forms a considerable traffic, especially on the Lancashire side—and of the many commodities loaded from Liverpool wood pulp is perhaps the most important, though, unfortunately, the Stanley Dock, to which the canal leads, has only very partial sheltered communication with the other docks, and the canal boats are not suitable for Mersey navigation. The canal is not the same depth throughout, and in particular will not take the large boats which use the Aire and Calder, so that a break of bulk is general at Leeds.

It is an unfortunate feature of the canal to suffer much from lack of water in time of drought, and a stoppage for several weeks for this cause is not uncommon. Less than one-twentieth of the tonnage uses the whole canal.

A canal from Wigan runs to Leigh and there connects with the Bridgewater extension from Worsley and thence to Manchester Docks. The opening of the Ship Canal Dock temporarily stimulated traffic on this portion, as it did on all the canals having Manchester connections.

The Upper Ribble and Aire valleys mark the most apparent weakening of the Pennine

System, and the next possible line of rail or canal communication must follow the upper valleys of the Calder on the Yorkshire side and the Roach in Lancashire. The headwater of these two streams approach each other within a few miles, and between them the canal attains a summit level of just over six hundred feet.

The thirty-three miles from Sowerby Bridge to its connection with the Bridgewater system at Manchester is called the Rochdale Canal and is only four feet deep, the Calder and Hebble and Aire and Calder continue the route in Yorkshire. There are fifty-six locks on the Lancashire side alone.

Manufacturing towns cluster in the steep-sided valleys almost up to the summit, and more goods actually cross the Pennines by this, than by any other canal route—even so the amount is insignificant. As we would expect, exchange with the Bridgewater system is much more important than with the Calder and Hebble, and only about sixteen per cent. of the traffic makes the whole length of the canal. A break of bulk is usually necessary at Sowerby Bridge, and hence there is little through mineral traffic which would not pay for handling. Coal and raw cotton are the most important traffic.

The two Lancashire links in the third and last Trans-Pennine canal route are the Ashton and Huddersfield Narrow Canals. In this instance, though the valley routes are singularly well marked, no summit level under 1,000 feet could be found, unless a considerable tunnel were used, and hence the Standedge tunnel was built. It is over three miles long, and only a few feet in diameter, and the long narrow boats have to be "legged" through. At Marsden, on the Yorkshire side of the tunnel, one may see the opening in the steep hill-side, looking more like a large sewer than anything else, while immediately above is the great railway tunnel, used every few minutes by the heavy traffic of the L. and N.W. Railway, Leeds to Manchester section But the canal tunnel below is hardly used, and one might wait for days, and not see a barge emerge. We may be less surprised at this if we remember that in the twenty miles from Huddersfield to Ashton there are seventy-four locks, only seven feet wide and three feet six inches deep. The Huddersfield Narrow carries less than the 100,000 tons per annum, and practically nothing passes the summit level.

The route is continued to Manchester by the Ashton Canal, which was opened in 1797, and is narrow and shallow, but carries, at a low level and amid more populous surroundings, more than twice as much traffic as the Huddersfield Narrow. Coal, cotton and grain are the chief traffics.

In books enumerating English canals emphasis is usually put on the fact that the above three canals (i.e. Leeds and Liverpool, Rochdale and Aston routes) give communication between coal-field and coal-field, and coast and coast; but we should remember that in each of the three canals the Pennine portions were the most difficult and expensive to build, contain the greatest number of locks, and are narrowest and shallowest. Also they were the last parts finished, and almost the first to feel railway competition. To-day the coast to coast canal traffic is insignificant, and even the Trans-summit traffic nearly so.

So far we have contented ourselves with what is little more than an enumeration, and not a complete one, of the Lancashire canals. Some value, however, may be derived from this if only the student follows with a map, for to know the canal routes of Lancashire is to know the relief of Lancashire. We summarise the matter by saying that two of the Trans-Pennine routes concentrated on Manchester, and hence have water connection with Liverpool, the third comes to Liverpool direct, but has a branch connecting Wigan to Manchester. The remainder, i.e. the Manchester, Bolton and Bury, and the Stockport concentrate on Manchester. We may put it, then, that in pre-railway days the main lines of communications in Lancashire were first those connecting all her big towns with Manchester, and, secondly, those connecting Manchester with Liverpool.

With the Mersey Estuary and the Manchester and Liverpool connections we shall deal in the chapter on Liverpool.

Thus we see that this network of canals was at one time almost the only efficient transport medium.

To-day its traffic has actually decreased and forms only a very small fraction compared with that of the railways. Let us examine as concisely as may be some of the causes for canal decadence.

What are the advantages of water traffic ?

Simply these—the relative elimination of friction, and the possibility of large carriers. A heavy barge can be hauled for miles by a single horse, and—save for the starting—with comparatively little effort. Or if a small tug be used the expenditure of power is less than would be required to take the same dead weight by any other means.

In the days of pack-horses and bad roads canals were bound to succeed, but water transport involves some disadvantage as compared with more modern methods of carrying, which, save in exceptional circumstances, entirely modify its one and no longer very marked advantage of cheap haulage.

Let us enumerate some of these :—

(I) Very little of any county is absolutely flat. How are undulations to be negotiated? A railway uses slight but long gradients, and, when necessary, cuttings and embankments; but a canal is, of course, *absolutely* level, and the cuttings and embankments must be larger and more frequent works.

The only other mode of passing hills is by using locks. Now a little thought will remind us that in the working of a lock a supply of water passes to a lower level, and therefore a water supply must be available at each summit. This is impracticable in the case of minor undulations, and so as to avoid these difficulties canals are constructed to keep a contour level as long as possible, to change level at as few places as possible, and therefore by flights of locks (e.g. at Wigan), and in general to have only one summit level.

Thus in hilly country they are usually more circuitous than railways and the locks and levels which make them possible are expensive to build and to enlarge. Further there is the expense of reservoirs.

II) Canal traffic is slow. If faster tugs are used the cost of haulage quickly increases, and the wash from the vessels seriously damages the earth embankments.

III) Connections and distributions. In these particularly lie the primary weaknesses of canals. A railway is capable of unlimited branching. It may send its metals into innumerable great works alongside. These works will have their own sidings—perhaps their own shunting engines and rolling stock. There can be made up wagons of manufactured material ready to be passed on to the Companies' lines and to be distributed by them. Similarly raw material may be collected from all quarters. The branching of a canal is an infinitely more serious undertaking, and is therefore much more limited. Thus, canals are now seldom used by any works not actually situated alongside.

(IV) Our canals, like our railways, were originally built in sections, but the mere connection of these does not yield the through route suggested by the continuous line on the map.

Thus, for example, there is a through waterway from Goole to Manchester, but it is made up of sections of very different depths and lock dimensions.

The type of carrier used on the Goole to Knottingley portion could not possibly be used on the Huddersfield Narrow Canal, say; thus, a break in bulk is required for each section, or only the smaller carriers must be used. Either condition entirely prohibits the present use of the canal for through traffic.

(V) Generally—it may be stated—a freight train employs fewer men in transit than are required in the movement of a similar tonnage by water.

With regard to North England, then, we may summarise the position as follows:—

(*a*) The Trans-Pennine canals *never* carried a heavy traffic.

(*b*) The Pennine flanking canals were of great importance to the third quarter of the nineteenth century.

(*c*) Only portions of the Aire and Calder, South Yorkshire, Bridgewater, River Weaver and Staffordshire Canals are of any considerable importance to-day, and these only for works on their banks and for such bulk freight as coal, grain, stone and salt.

(*d*) No steps have been taken to give effect to the recommendations of the Canal Commission (1912) for the improved connection of Mersey and Thames and of Humber and Bristol Channel—the two systems crossing in the Midlands. Traffic, even on those parts of these systems much used, is very local in character, and is steadily dwindling.

The railway companies which bought up so many of the canal concerns did little to encourage their use; but, on the other hand, there is much to be said for the view that railways form a more economic transport agency, save in a few quite exceptional cases, and that the subsidizing of what is inherently an obsolescent system would not be for the general welfare.*

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* The railways themselves, for certain classes of goods, and for similar reasons, are yielding to an improved road motor service, while for lighter goods the possibilities of aeroplane traffic are not negligible.

# CHAPTER IX

## THE MERSEY, LIVERPOOL, AND THE ALKALI INDUSTRY

ON the low coasts which lie between the Furness peninsula and the Welsh mountains are scattered a number of minor settlements and a few ports. Liverpool was not always the greatest of these, and we may think of it as having grown in competition with the others and so examine the relative advantages of a situation which rendered this possible.

The sand banks which fringe the Lancashire coast hindered incipient port growth save in the great estuaries, each of which had early its representative port.

Preston, situated on an easily fortified hill in part surrounded by the river Ribble, at the head of a navigable estuary just where it might be bridged, represents a familiar type.

Its position is comparable to that of Warrington or of Lancaster, and like them it has always been a route ganglion on the western road to Scotland. For a short period, in the reign of Charles I, and before it suffered so severely in the Civil War, it was accounted the richest of Lancashire ports, for Chester had by then declined and Liverpool was only very slowly developing. In contrast to the situation of Liverpool we may notice the shallow estuary of the Ribble with its silting channel and more difficult connection with the Manchester district.

Chester was the most important of all north-western ports from the time of the Romans to that of the Tudor kings, but the gradual silting up of its harbour was too severe a handicap for real competition with the open roadstead of Liverpool and it lost its trade to that port.*

This happened while the trade of the Irish Sea was still almost wholly of British origin, and at the very beginning of the industrialisation of Lancashire the old strategic and ecclesiastical centre had not a single physical point of advantage over her young rival. Her trade steadily dwindled from the sixteenth century on, and the subsequent canalising of the Dee came too late, and was too insignificant a work, to be very effective.

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* In 1565, Chester claims that "Liverpool is only a creek of its port," i.e. Chester's.

Now let us look a little more closely at the factors concerned in the development of Liverpool itself, and this will necessitate in the first instance a study of the Mersey estuary, which may be properly divided into three parts—the outer and inner estuaries, and the channel connecting them.

The outer estuary approximates to a right angle in form, and includes the irregular succession of sand banks which form the Mersey bar. The falling tide reveals these banks and a number of channels, mostly very shallow, intersecting them. The deepest, most permanent and most used of these is the route formed by the Crosby and Queen's Channel, and here, where already there was considerable tidal scour, modern dredging operations have effected very great improvements. (Fig. 21).

We should bear in mind that a ship drawing more than about a dozen feet of water is an invention of the last century, and, further, that this estuary has the advantage of a considerable tide, so that the minimum depths of ten feet available at the bar, or the sea end

**THE MERSEY ESTUARY**

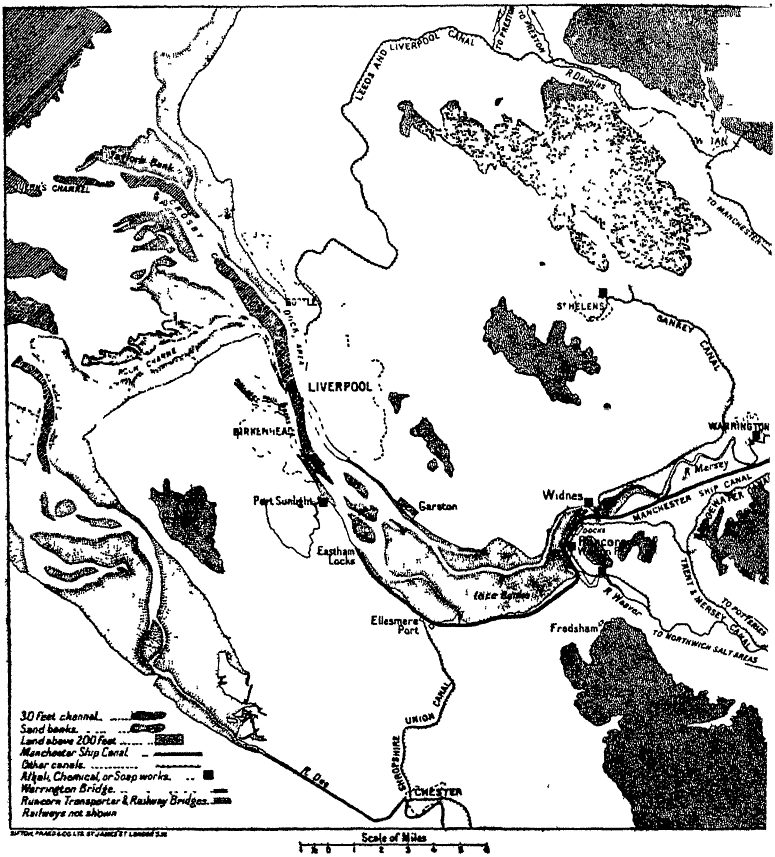

FIG 21.

of Queen's Channel, was of little hindrance to shipping until the last twenty or thirty years, for at high tide this depth was increased to anything between thirty and forty feet.

Liverpool was then the second port of the world, and could afford, as modern engineering could devise, the effective sand-pump dredging which between 1890 and 1912 has provided a tidal range in the channel from twenty-seven feet L.W.S.T. to sixty-one H.W.S.T.

This deepening of the natural channel concentrated upon it the tidal flow, and so increased the erosion of Taylors Bank that the curvature there, already considerable, was becoming dangerously accentuated. If this had been allowed to proceed there would come a time when the sharply bent channel upon which so much money had been spent would be discarded, while the river formed a subsidiary and more direct route to the sea.*

To avert this danger the concave edge of Taylors Bank has been protected with Limestone rubble for two and a half miles ; but provisions of this sort are seldom sufficient or permanent, and ultimately it may be advisable to undertake the prodigious work of constructing walls from Bootle to Taylors Bank.

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* See *Rivers and Estuaries* by W. H. Hunter, (Longmans, Green & Co.).

The inner estuary, which off Ellesmere Port attains its greatest width of three and a quarter miles, contrasts with the connecting channel, never more than half that width and seven miles in length. The greatest constriction is opposite Princes landing stage, Liverpool, where the width is only about one thousand yards. This constriction retards both the flow of the tide to, and the ebb from, the inner estuary; and the consequent heaping up of waters alternately on either side of the narrow opening produces in it a current which sometimes attains the velocity of seven miles per hour and always provides an effective scour.

Above Frodsham the estuary narrows normally with one important and well-marked exception. At Runcorn the shores are only four hundred and fifty yards apart, and though the tide rose too high for fording, and the gap was too wide for bridging in early times, yet its comparative narrowness has attracted both a railway bridge and a transporter bridge in recent years.

Warrington, at the head of the estuary, has an interesting situation. Here was the lowest ford* on the river; the lowest and one of the earliest bridges (thirteenth century), and the limit of effective navigation. Warrington then was essentially a bridge port, though it only attained really considerable position as a port in the period 1700-70, i.e. *subsequent* to the improvement of the river from Runcorn to Warrington, but *prior* to the alternative route offered by the Bridgewater Canal from Runcorn to Manchester.

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* i.e. Latchford—a little to the east of the present town.

Throughout history it has commanded the main north and south routes to the west of the Pennines.

English estuarine ports may be divided into two classes. Like London, Gloucester or Preston, they may be at the head of the estuary and at the site of its lowest bridging; or like Hull and Liverpool they may owe their earliest settlement to the junction with the estuary of some small creek or river, which afforded the landing facilities and shelter denied in the estuary itself with its great tidal range, its spread of lateral mudbanks, and its strong currents.

The former type was the more frequent.

It was also, with some great exceptions, the least able to cope with modern conditions. The facilities big estuaries offered were well enough in the pre-dock days of small boats, and they had also the very real advantage of greater ingress to the country. But the economies arising from the use of big boats were evinced before engineering science was in a position to deal effectively with estuarine improvements.

The lower estuary port—the Hull or Liverpool type—with its more immediate deep water, now came into its own. In place of the little creek or river, the original nucleus of settlement, would appear the gradually extending line of lateral deep-water docks ; and modern transport facilities—road, canal and rail—would seriously qualify the one considerable advantage left to more inland ports.

At Hull, the original harbour, the river Hull, is still lined with warehouses and mills, and swarms with lighter traffic ; but the pool of Liverpool, the origin of its settlement, the site of its first dock, is now built over and is indicated only by the valley running from the Custom House through Paradise Street and Whitechapel.

A more considerable creek—Wallasey Pool—existed on the Cheshire side, exactly opposite, and at one time afforded temporary protection for vessels whose actual trade was with Liverpool. The position was inferior to that of Liverpool, however, in the matter of connection with the main South Lancashire industrial area, and Birkenhead, which now occupies this site, is a port of quite recent growth.

There is almost no trace of the early trade of Liverpool until Tudor times. We know that it was small and mostly with Ireland; that it was often interrupted by war, and that the port was the point of embarkation of many a military expedition. Three hundred years after its foundation there were only five or six streets and about one thousand inhabitants, while the harbour owned fifteen vessels (total tonnage 268) manned by eighty men and boys. In the sixteenth century the imports were mostly Irish linen yarns, hides, and tallow; while textiles (wool and linen, *not* cotton), alum, and Sheffield knives were among the chief exports. In 1635, the High Sheriff of Lancashire describes the port as "gone a begging," and unable to pay much to ship money.

In accounting for this we must bear in mind, first, that the trade of the country was largely with the Continent and favoured south and east ports ; and then, when West India trade began it used just at first the older-established ports of London and Bristol ; and, finally, an extent of marshy country (Chat, Risley and Barton mosses) and a stretch of unnavagible river separated Liverpool from Manchester, whose chief port both for raw materials and finished goods was London.

From 1650 onwards there was a rapidly increasing import of West-Indian sugar and tobacco at Liverpool, and refineries were started at the port. In the second half of the eighteenth century too our cotton supply was chiefly from the same source, so that the port's very real advance between the years 1650 and 1790 must be definitely associated with West-Indian trade and with an increasing export of manufactured textiles.

The same period witnessed the steady growth of that most reprehensible of traffics, the slave trade ; and it is usually considered to have been a very great stimulus to the development of Liverpool. In 1709 a little Liverpool vessel of thirty tons left the West African coast with a cargo of fifteen negroes, and the port's share in the traffic steadily increased until in 1792 it is estimated at three-sevenths of that of the whole of Europe. Between 1783-93 Liverpool vessels made eight hundred and seventy-eight round trips, taking over three hundred thousand slaves to be disposed of for a sum of over £15,000,000.

It would indeed be difficult to over-estimate the importance of this trade in the progress of the port. It meant far more than the mere money which Liverpool merchants obtained. It really stimulated commerce, for it soon formed the staple of a very valuable triangular trade route.

The Liverpool-built boat (a large, fast clipper, specially designed for its human freight) left Lancashire with spirits, cheap muskets, ornaments and rough textiles. These were exchanged on the West African coast for negroes, who were then taken and sold in the West Indies and (after 1720), to a gradually increasing extent, in the American States. The boat then returned with sugar, rum, tobacco, and cotton. Thus there was valuable freight all the way. Soon a similarly satisfactory triangular route was followed by the finely built boats of Puritan New England.

We emphasise this traffic because it was bound up with a most extensive and more legitimate commerce with the new world. It was not mere position relative to America which gave Liverpool the advantage over such ports as London and Bristol. That was a minor point. It was the relative nearness of a manufacturing hinterland giving readier possibilities of return freights in times of very expensive transport; and, further, it has been ascertained that at this period (the second half of the eighteenth century) Liverpool was a cheap port. Labour rates on ship and on shore were relatively low.

Contemporaneous with the growth of West-Indian trade was the development of commercial relations with Spanish colonies in Central and South America.

Little direct trade was done with our American colonies until the end of the seventeenth century, when the tobacco of the Central and Southern States, and the timber, fish, skins and ships' stores of the Northern, began to come in ever-increasing quantities to Liverpool, so that the American mainland trade eclipsed all others. The import of American (as contrasted with West-Indian) cotton did not begin until the very end of the eighteenth century.

For more than a century now the connection of Liverpool with the Lancashire cotton industry has made her staple import raw cotton, and her staple export manufactured cottons. But the Lancashire cotton market is world wide, and the commercial relations of her port must be no less. Cotton, raw and manufactured, represents one-third of the port's value trade.

Again, a large portion of our cotton manufactures go to relatively undeveloped countries; but it is just these which offer a market to all manufactures ; and there is no industrial area in England but sends some of its products to Liverpool for export. From the very nature of the traffic proper to Liverpool as the port of Lancashire comes the variety which makes her just as really the port of the country.

Finally, what single port is so geographically accessible, either for the receipt of manufactured goods from our industrial areas, or for the sending to these densely populated districts imported foodstuffs ? London has a larger total trade, but a greater proportion is entrepôt. No port rivals the export figures of Liverpool.

London and Liverpool each do well over

one-quarter of our total foreign trade, and there is no other of our ports with at all comparable figures.

With so populous a hinterland and so extensive a trade Liverpool is far from being a specialised port. Though it exports a lot of coal (chiefly through Garston), and requires a large amount also for bunker purposes, it is not in any special sense a coal-exporting port. Indeed much coal of special quality, e.g. Welsh steam coal, is brought in coast-wise for use in its great liners, and altogether it deals with less than Hull.

Like London and Hull it has a great import of wheat, meat, sugar and foodstuffs generally; though naturally these are much more largely of Canadian, United States and Argentine origin than is the case at the Eastern ports. In tobacco, in rubber, and above all in the import of raw and export of manufactured cottons, no port has figures at all comparable.

Garston, which is included in the Customs port of Liverpool, is really five miles farther up the river, and as its docks are quite modern there is plenty of room for the special sidings and appliances necessary for the economic shipment of coal. These docks are the property of the L. & N.W. Rly. Co., and deal most largely with coal, mineral traffic generally, and timber.

A chronology of English waterways shows very clearly that the greatest activity in canal building occurred in the period 1770-1810, and the dates at once remind us that the development of our system of inland waterways was intimately connected with the unprecedented industrial activity of that time. Amongst English counties Lancashire took the lead in canal construction, as was natural in a county so early industrialised; and as was generally the case, two stages in the development of her water transport are clear. First comes the improvement for navigation of river and estuary—a natural development of historic coastal routes—and then later, the use of entirely artificial waterways.

Throughout the last three centuries, and whatever the transport medium, there has been one link of pre-eminent importance in the chain of Lancashire communications; that by which her port is connected with the merchant city. We have seen that water transport had always been possible, though unsatisfactory, between Liverpool and Runcorn, and occasionally to Warrington; but this was so difficult and so little used that we must emphasise the bridge with its convergence of routes rather than the port in the development of the latter town. However, there is evidence that a little prior to 1697, the river had been "Cleaned" to Warrington, and from this we may date the increasing use of Warrington as a port, and the existence of an effective water stage in the route from Liverpool to Manchester. Lighters from Liverpool could then reach Bank Quay, Warrington, on the tide, and in 1720, when an Act authorised the construction of locks, weirs, and cuts on the rivers Mersey and Irwell, sufficient to render that system navigable to Manchester, the natural route as far as Warrington remained free of dues.

Thus early was there water communication between Lancashire's two chief cities; but it was unsatisfactory -a shallow, dangerous, shifting channel as far as Runcorn, and the lock above Warrington only to be entered at the height of the tide, and then giving access to a circuitous route with many locks.

An Act for the improvement of the River Weaver in 1720 led to the connection of the

Cheshire Salt district and the Mersey navigation. The river Douglas (opened 1727, and largely artificial) connected the important coal centre of Wigan with Preston, and, such was the lack of efficient inland communication, thence with Liverpool by coasting vessels.

An Act of 1755 authorised the cut from St. Helens* to the Mersey, fed by the Sankey Brook. This little work is now practically derelict, but it was effective in its day, and served—like the Douglas navigation—to connect the coal-field with an estuary. St. Helens coal found its way to Liverpool and Cheshire (via the Weaver), and in return salt, sand, copper ore,† and general commodities (from Liverpool) did much for the development of the typical industries of St. Helens.

The canal is to-day thirteen miles long, has ten locks, is six feet deep and divides into three branches in the St. Helens neighbourhood. Little coal is now carried, and the chief traffic are river sand and alkali to St. Helens. Some chemicals are sent down to the Mersey, but the traffic done is small.

To Brindley, who knew no use for a river save that it should feed a canal, the circuitous

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* On the coal-field area.

† From Anglesey.

Mersey and Irwell navigation must have seemed a poor thing, and he soon had plans ready for a canal (Bridgewater), which should follow one level (a little below the 100 contour) through Stratford, Sale, Timberley, Lym and Preston Brook, and drop by a flight of locks—the first of their type in the country—to the Mersey at Runcorn. This connection was opened in 1767, and considerably increased the traffic between Manchester and Liverpool. Its complete financial success stimulated canal construction throughout the country.

This Bridgewater canal, together with the Mersey and Irwell navigation were acquired by the Manchester Ship Canal Company, and the main branch is now useful in relieving the Ship Canal of barge traffic.

Its later connections with the Ashton, the Bolton and Bury, and the Rochdale Canals at Manchester; with the Leeds and Liverpool at Leigh, and with the Trent and Mersey at Preston Brook, much increased the traffic on the main system, and are still maintained. The main line between Manchester and Runcorn is twenty-eight miles long, and will not take barges more than fifteen feet wide or drawing more than four feet four inches of water.

Liverpool is only thirty-six miles from Manchester, and probably no two considerable towns have better transport connection to-day ; so much so, that it is difficult for us to realise what a critical factor that thirty-six miles has been in the history of the two places.

The estuary, as we have seen, only reached half-way and presented many difficulties to navigation; thus until the canal era Manchester port connections remained with London, and to a less extent, using pack-horse and the Trent or Severn, with Hull or even with Bristol.

The Mersey and Irwell navigation and the Bridgewater Canal, established useful communication, but from 1846 onwards, transport between the two towns became more and more a railway monopoly. The first line was opened in 1830 and was almost as noteworthy for the difficulties overcome in the crossing of Chat Moss as for the evolution of a practical steam locomotive.* To-day three main lines share the traffic ; there are very frequent express trains and no two cities are better served.

In the last quarter of the nineteenth century

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* A history of the communications between Manchester and Liverpool is an epitome of the whole history of transport—estuary, river, canal, road, railway and ship canal.

Lancashire suffered a depression in trade, and Manchester merchants were never tired of hinting that among the chief hindrances to their prosperity were the heavy rail freights and harbour dues operative in their commerce with Liverpool. Then the suggestion—which had been made off and on many times in the preceding half-century—to make a deep water canal right up to Manchester, entered the range of practical politics; and after the customary opposition from representatives of various interests who imagined that to them the venture would be injurious, a Bill authorizing the Ship Canal was passed in 1885.

Nine years later, i.e. three years after the promised time, and at a cost of about four millions more than was anticipated, the canal was opened for traffic. It had been a difficult piece of work. A rise of fifty feet had to be effected by four locks; a channel of twenty-six feet (now twenty-eight feet), and for about one-fifth of the length it was through sandstone rock, had to be excavated. From Eastham to Runcorn the canal was practically embanked against the side of the Mersey. Five previously existing railway lines and one canal had to be carried over it—the lines by approach embankments and bridges; the canal (at Barton) by a swing aqueduct 235 feet long, 6 feet deep and weighing 1,450 tons. Then there were the connections at various points with existing canals and with the Mersey to negotiate, and lastly the provision of docks, not only the large ones at Manchester, but subsidiary ones at strategic points *en route.*

Several of these minor docks are attaining real commercial importance and we will give them attention in a brief survey of the canal from Eastham to Manchester.

The canal opens by three tidal locks to the Mersey at Eastham, five miles from Liverpool, and soon narrows to its normal bottom width of 120 feet. Port Ellesmere is the first place of interest reached. Here comes the junction of the Shropshire Union Canal which previously entered the Mersey at this point but now does so via the Ship Canal at Eastham. Docks are provided and railway sidings connect with the line from Frodsham which approaches here on its way to Birkenhead.

Deep water, railway, and barge connections, and cheap rents, have already attracted heavy industries to this district, notably some cement and chemical works.

Near Runcorn is a most interesting route concentration. The river Weaver with its salt, the Bridgewater Canal connecting via the Grand Trunk with Staffordshire and the potteries, and the rail across the Mersey at Runcorn gap, all give the Ship Canal exceptional importance at this place. At Weston Point salt is put on large liners trading chiefly with India, and a little nearer Runcorn itself are highly specialised and quite considerable docks. Of interest here is the fleet of small sailors* which still bring the china clay round from Cornwall. It is transhipped in the docks to narrow barges for Staffordshire. Large sheds are full of this material, and elsewhere on the extensive quay-side may be seen stacks of flints (from the chalk ports of the English Channel), slates, and pig-iron which, with the clay, form the bulk of the traffic of this canal port.

Near Warrington there is a coal-shipping wharf, a wharf for general shipment, and a lock connecting with the Mersey. Latchford lock, twenty-one miles from Eastham, gives a rise of fourteen and a half feet, and the crossing of the railway at Partington has

* Three hundred ton vessels.

resulted in the provision of the most extensive facilities for coal shipment to be found on the canal, while the rail and port connections have quite recently attracted large iron and steel works. At Irlam and at Barton (where the Ship Canal passes under the Bridgewater Canal, a section of which is both a swing bridge and an aqueduct), there are locks giving a rise of about fifteen feet each, and at this point too the canal bottom widens to 170 feet. At Irlam is an important group of blast furnaces. Just above the last lock the canal enters the Manchester dock proper. Transhipment is here possible for the Bridgewater, Ashton, Rochdale, Huddersfield and Bolton Canals.

The area lying immediately to the south of Eccles and Salford is really an extension of the Chat Moss and consequently was level, little occupied and subject to floods. It included some big estates since taken up by the Canal Company. Thus there was no cramping in the provision of railway sidings, quay and warehouse space, and timber storage ground. In general there is room for industries dealing with bulky raw materials, and these are being attracted to the Trafford Park Estate.

Few, if any ports in the world, have throughout such up-to-date facilities—three and four story warehouses with roof cranes and covered railway sidings, ample cold storage, and quite special accommodation for dealing with grain cargoes. Indeed, any criticism should be directed to the overzealous preparation for certain traffics which have not as yet adopted the port.

Manchester is a rather more specialised port than Liverpool. It imports about one-fifth as much cotton as Liverpool and cotton traffic represents half its total value trade. The ample space and immediate market have attracted the timber trade at the expense of Liverpool, and the tonnage of near continental boats using the port is actually greater than at the older port. It is the second oil port and the fourth wheat port of the United Kingdom. Cotton, raw and manufactured, wheat, timber and oil are the chief traffics of the port, but it has excellent facilities for dealing with any class of goods whatever.

There is no doubt that with regard to a number of commodities, very real economies are effected by shipment to Manchester, and the accommodation of the port is beyond cavil. Why then its slow growth ? We get no better instance of trade inertia. There is a tendency, because of existing interests, for traffic to be carried on where and as it has been carried on, even when more favourable routes and facilities appear. The distribution of shipping lines depends in part upon the quantity and variety of commodities already dealt with at ports. Ship-owners wished to be assured of regular, full and return freights. Again the ship-owner may have to arrange his lines in accordance with the somewhat arbitrary dictation of a shipping ring. And these influences have not always been favourable to Manchester.

In fact the shipping ring, the ship-owner, the shipping agents, had all to be persuaded that Manchester shipment would be for their individual profit.

In any assessment of the value of the Ship Canal we must take into account its economic influence as a potential carrier as well as its actual traffic.[*] And the undertaking has been of unquestioned advantage to Lancashire and the North generally. The enormous population within twenty miles of Manchester receives and sends goods via many British ports.

[*] See *The Economic Value of the Ship Canal to Manchester District*, by Jas. McConechy, Manchester Statistical Society, 1912.

The Ship Canal gave the alternative of a complete sea route; and down went the railway rates at the mere possibility of competition; especially, but by no means only, those operative between Liverpool and Manchester. Further, the Mersey Dock and Harbour Board at once made reductions in their dues.

*The Cheshire Salt Industry and Its Mersey Connections.*—It would seem that arid conditions attended some part of the period of development of the Triassic rocks, for in mid-Cheshire, in South Durham and about Fleetwood in Lancashire great salt deposits occur in this formation, and are apparently the remains of dried-up inland seas.

The deposits in Cheshire are found in two beds, each 100 feet in thickness, and at depths varying between 200 feet and 500 feet. The purer deposit is in the lower bed. They occur in areas stretching from a few miles north of Northwich, passing through Winsford and terminating about Lawton. Brine springs have been known and the salt extracted here since Roman times.

Many shafts were sunk to the upper bed, and for a period the mined output exceeded that of the brine springs; but it was found that the mines in nearly every case fell in eventually through water penetration, and for long now the production has depended almost entirely upon brine pumping.

Salt soon became an important article of export from Liverpool. When the trade was at its height, e.g. between 1870-80, ten million tons of salt was shipped from the Mersey, about one quarter of this going to India and a quarter also to North American ports.

The shipment of salt still continues—particularly to India, great areas of which sub-continent are far from any deposits. Moreover, since our imports from India are much bulkier than our exports to that country, salt is usually taken at ballast rates.

Now, apart from its general domestic use with food, salt forms the base of the great alkali industries, and consequently of a number of subsidiary chemical industries.

In particular, combined with certain fats and oils (animal and vegetable), alkali is a necessary constituent of all soaps, and we must remember that the use of these is by no means confined to domestic and laundry purposes. As we have already noted, great quantities are required for wool scouring and finishing. In fact, the textile industries are quite specially dependent upon the supply of alkaline productions (*e.g.* bleaching powder is largely used in these industries. Caustic soda is used in great quantities for mercerising).

Before Le Blanc's startling discoveries at the end of the eighteenth century, alkali was derived from ashes of wood, or of sea-weed origin. In Mediterranean countries, where the weed could be easily sun-dried before burning, it was used for this purpose, and as late as 1834, we received 12,000 tons of crude alkali (called " barilla ") from Spain alone.

Le Blanc treated salt with sulphuric acid and so obtained sodium sulphate (salt cake), and hydrochloric acid. Happy accident, or a most extraordinary instinct (considering the chemical knowledge of his time) led him then to heat this salt cake with a mixture of chalk and charcoal. Lixiviation of the resulting charred mass yielded a solution of sodium carbonate and an insoluble residue. For more than eighty years this remained the method adopted for the production of soda from salt.

The industry required first of all salt itself. This was available in the Weaver basin.

Then it required coal both in the process itself (instead of charcoal) and for the generation of heat. This was available by water after the opening of the Sankey Canal from the South Lancashire coal-field to the Mersey, and after the improvement of the lower Weaver, so that the coal might be taken on to the salt area. It required a limestone, and this was brought from the limestone quarries of the Southern Pennines. It required sulphuric acid in great quantities; and at first this was produced from sulphur imported from Sicily. Later it was found more economic to import iron pyrites (rich in sulphur) from Spain, as after the extraction of the sulphur and copper an almost pure iron ore was obtained, the "purple ore" of commerce, which could easily be disposed of to iron-furnace operators.

Some fifty years ago a cheaper method of converting salt into soda was perfected—the Solway ammonia process. A great proportion of the yield is now by this process, and the Le Blanc method would have become obsolete but for a number of inventions by which valuable bye-products were extracted from formerly wasted materials.

Thus the hydrochloric acid gas is no longer allowed to desolate the country-side, but is condensed, and the chlorine used to make (among other things) bleaching powder. The sulphur, so necessary an ingredient in vulcanising and other industries, is also now recovered.*

We need not concern ourselves more closely with methods of production here, save to notice that the manufacture of soda, of soap, of bleaching powder, and of the heavy acids incidental to the industry have necessitated the assemblage of bulky raw material, e.g. salt itself, limestone, coal, iron pyrites, oil-seed, etc. Again much of the alkali is exported, and at home all our industrial areas, and particularly the textile areas, consume great quantities of alkali, and of heavy acids.

This, then, is essentially an industry which requires good water connections for its most economic development.

The river Weaver was the main artery in this circulation. Even to-day it shares with the Aire and Calder system the distinction of being one of the very few waterways of really heavy traffic in England. And the river

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* Electrilytic methods are being increasingly used with coal (in this country) as the original source of power.

Weaver now joins not merely with the Mersey estuary, but with the Manchester Ship Canal and its port connections.

Coal is now largely brought to the works by rail, but salt still chiefly uses the river, though some diminution in traffic has been caused by the recent use of brine pipe-lines, which take the brine right away to the estuary side (e.g. at Weston Point) for evaporation, and increase the tendency of the industry to concentrate at the estuary towns at the expense of the original salt district.

Bearing in mind the chief requirements of the industry and the necessity of a port connection, we should have little difficulty in accounting for its development (i.e. of alkali, soap and heavy chemicals works, generally) at such places as Liverpool, Port Sunlight, Western Point, Runcorn, Widnes, Northwich and Winsford. They are all on the same waterway system, and the Ship Canal appears as something more than a connecting link between two great cities. Effectively, it is also an addition of some forty miles to our industrial coast-line.

# CHAPTER X

## THE LOCALIZATION OF INDUSTRY

In Northern England all that is usually meant by Localization of Industry is plainly exemplified. The term has come to connote the gathering of industries, formerly perhaps widely scattered, into a few areas of specially favourable environment; and, as we have seen, this re-distribution has been so complete that certain areas have become definitely associated with certain industries.

This tendency to segregation was particularly noticeable during the whole of the Industrial Revolution, though, as is the case in the other main characteristics of that time—the evolution of transport, the growth of the factory system, the use of mechanical power—as a tendency it was apparent before the period of its most active development.

The great inventions which characterised that period were not related merely to the use of new sources of power, but to thei adaptation to more complicated systems of movement than those involved in the tilt hammer and the grain or fulling mill; that is to say, to such relatively elaborate machinery as the water frame, and the power loom. And the industrial re-distribution begun under these influences was most marked towards the close of the first half of the nineteenth century, when the steam engine had become the usual prime mover.

Before this elaboration of machinery the supply of manufactured articles was comparatively low, their making domestic, and the traffic in them largely local. The most populous districts were those best suited to agriculture. Geographical control was limited here to climate and soil, though in the location of town and village sites such factors as route concentration and water supply are everywhere apparent.

With the use of complex machinery began an era of rapid dependable production and of bigger output per man employed. Man's requirements increased as his wants were supplied. Overseas markets were developed. The home population also rapidly increased. Consequently there was a great increase in the quantities of raw materials used, and particularly of coal, which by 1840 had become the main source of power supply.

Now in every industry, or process of an industry, in which an article of commerce is produced, three main stages are discernible.

(I) The gathering together at the site of manufacture of the raw materials* required. This presupposes usually a concentration of several transport routes.

(II) Then there is the actual manufacture this involves a population at the site of the industry skilled in the work, and not so isolated but that it may receive foodstuffs and manufactured articles for its own use.

(III) The distribution to markets ; and here either the site considered is itself a centre from which traffic-ways radiate, or, more frequently, the initial stage is to a distributing centre—some great city or port upon which routes have concentrated, and concerned with the reception, handling and distribution pertaining to many and various industries.

Thus facilities for transport are involved in every stage of the industry. They are the determining factors in its localisation.

The locations of raw materials, of primary markets, of sources of skilled labour, may all be considered as points from which attracting forces are exerted on an ideal factory site, and under the influence of which it assumes a position of somewhat unstable equilibrium.

The attracting force in each case is a function of the cost of transport, and that again of the effective distance to be covered. We use the term effective distance because the cost of transport is not generally proportional to the actual distance, but is conditioned by many other circumstances.

The nature of the transport offered is the chief of such conditions. We noticed that Brindley's first canal much reduced the effective distance, so far as coal was concerned, from the Worsley mines to Manchester. From St. Helens overland to Preston is a shorter distance than via the Sankey Canal, the Mersey and the open sea ; but the latter was for a time the lesser effective distance.

High gradients, or the use of transport media involving extra handling, as in, say, the change of goods from the big carriers of a large canal to the small barges of a communicating branch; these are conditions which tend to increase the effective distance. Or again, the effective distance may be considered to be lessened by the possibility of a return freight. The price of bread and of timber in this country is adversely affected by a falling off of our coal exports; for coal is often a return freight for wheat and timber received. Then the transport charge varies with the nature of the articles carried, and since it is impossible to estimate exactly the actual cost of transport services with respect to any given article, freight classification charges are apt to be somewhat arbitrary. Further, even for the carriage of one particular class of goods, a charge proportional to distance, i.e. a flat rate, is frequently not used, and the effect of the actual distance may be masked by a zone rate, or a rate preferential to a certain route.

We see then that the various forces of attraction to which our ideal factory site is subjected are not to be measured in terms of the actual distances involved.

The attraction then, say of some one

essential raw material, will be most effective upon our ideal factory when transport facilities are least developed, return freights difficult to procure, and the raw material itself heavy and bulky. Thus an industry requiring heavy raw materials, but producing relatively light products, into the final cost of which manufacturing labour charges bulk largely; such an industry is situated with particular regard to the position of its raw materials, and if there be several of these, with special reference to those required in greatest weight.

This is the most usual case. The bulkiest and heaviest material concerned is frequently the source of power—the coal itself. The most striking single phenomenon in the redistribution of industry in the nineteenth century has been its concentration upon the coal-fields.

It remains to notice that, our factory once established, two sets of influences are ever at work with respect to its location; the one adding, as it were, to its inertia, and tending to the maintenance of its position; the other, the outcome of variations in its environment, and tending to a migration.

Let us consider first the factors of inertia

Of these the capital sunk in building and machinery is perhaps the chief; but custom, good will, the evolution of a local supply of skilled labour, the economies accruing to a whole industry by the juxtaposition of similar and subsidiary industries all these are forces inimical to change.

On the other hand, the forces which determined the original localisation are liable to cessation and to variation. For example, the discovery of a new, better or more accessible source of a raw material will quite alter the insistence of the older source of supply. The migration of our iron industry from forest to coal-field, and from inland site to sea-board, illustrates this point. The big port concentration of our modern milling industry is another instance.

Then again each change of, or addition to, transport media is an alteration in the general environment of an industry, and the consequent re-distribution of forces may result in a change of location.

The general effect of improved transport conditions, however, was first more definitely to confirm the localisation, for these early improvements were undertaken just because of some *tendency* to localisation which already existed.

To give but one illustration of this point. The presence of suitable and accessible coal and clay marls were factors in the establishment of early pottery work in North Staffordshire. The inventive skill and artistry of a few men, and the acquired aptitude of the local labour supply fostered the industry. The increasing use of China Clay fron Cornwall made its development and stability depend upon improved means of transport. The opening of the Trent-Mersey Canal saved the industry and intensified its localisation.

Now, obviously, local specialisation is only possible with transport of some kind, but it was the natural advantages which certain localities offered to certain industries which begot in each case the *beginning* of localisation, and consequently the very need for transport development. Such development then became a very part of the favourable geographical environment of the industry.

Transport efficiency may, however, reach a stage such that the actual location of certain industries is of little importance. The concentration of raw materials and the distribution of products, the attendance of work-people, these may be effected at costs which are a very small part of those involved in the total manufacture. When raw materials and products are light and small, expensive possibly, but not because of the distance from their origin, in such cases the choice of a site for work is much more a question of rent charges and of supplies of labour than of the position of raw material or of markets. Further, transport development may even effect a partial decentralising influence.

The same may be said of the increasing use of electric power transmission. Waste is at present entailed by the elaborate distribution of coal to a multitude of factories, many of which are equipped with boiler plant of very low efficiency. The same amount of coal would supply more energy if used at modern power stations with electrical distribution to the factory sites. For the greatest economies such stations should be large, and carefully sited with regard to facilities for the receipt of coal. The extension of such power systems would obviously loosen the hold of coal-field on industry, especially perhaps on those industries most independent of subsidiary or allied production. The increasing use of oil power will have a similar result.

Now all we have been saying in this chapter as to the suitability of certain districts to certain types of industrial activity applies in a wider sense to Great Britain generally in its relation to World Industry. Here, and in this larger view, within a very small area, were accessible supplies of the fundamentals of modern industry—coal and iron. The coastal relationships were such as facilitated the import of other necessary raw materials and the distribution of manufactured articles.

Here, too, we like to think, was a people of adventurous spirit, not lacking in initiative and imbued with a certain dogged optimism. The more detailed the study the more certain becomes the conviction that no country was influenced by a general environment more favourable than was ours for the establishment of industry in the early nineteenth century.

And so looking back from the twentieth century we see that use was made of our unique opportunities; that for long this country led the world in manufacture and in international commerce.

But we do well to remember not only that such a position was largely the result of our general environment, but also that the favourable factors in that environment, though still effective, have no longer quite the relative importance that distinguished them in the earlier period.

Our continental neighbours have established and maintained industries in circumstances generally less favourable. Indeed, in certain instances, the comparative difficulty of the task seems to have stimulated invention and to have engendered a more scientific use of material.*

In the United States an unparalleled natural wealth has been exploited under conditions which have served to demonstrate the economies accruing to large-scale production and handling.†

But neither in Western Continental Europe nor in North America was the general location of industry so favourable to international commerce as in this country.

* Witness the early use by Germany of bye-product ovens, or again her prompt use of dephosphorising steel processes for the Lorraine ores.

† e.g. the lake and rail traffic concerned in iron and steel work and in wheat export.

In this respect, though we have maintained a priority, the increasing industrialisation of hitherto undeveloped lands may ultimately affect us adversely.

Japan, once a purchaser of our finished textiles now competes with us at home and in the Far Eastern markets. India shows a tendency to produce finer yarns, and therefore to compete more directly with the class of goods which we have been accustomed to send to her.

Our colonies are naturally attempting to foster the development of their own industries. But it is as easy to exaggerate as it is difficult to assess the import of these tendencies.

That our industrial production *relative* to that of the world generally should have dwindled, was obviously inevitable.

The question is rather as to whether the general environments of our industries will prove still sufficiently favourable to enable us to maintain the *absolute* scale of our production.

IRON ORE RAISED IN THE BRITISH ISLES IN MILLIONS OF TONS.

| | | 1850* | 1860 | 1870 | 1880 | 1890 | 1900 | 1910 | 1919 | 1922 |
|---|---|---|---|---|---|---|---|---|---|---|
| COAL MEASURES ORES | | 6-7 | 5.17 | 6.5 | 5.4 | 2.06 | 1.77 | 1.7 | .98 | 0.27 |
| JURASSIC ORES | (*a*) Cleveland | 0. | 1.5 | 4.07 | 6.49 | 5.61 | 5.49 | 6.15 | 3.71 | 1.17 |
| | (*b*) Lincolnshire<br>Northants<br>Leicestershire<br>Oxford, Rutland, etc. | 0. | 0.2 | 1.27 | 2.88 | 3.44 | 4.4 | 5.5 | 5.99 | 4.49 |
| CUMBERLAND AND FURNESS | | 0.28 | 0.99 | 2.1 | 2.7 | 2.4 | 1.7 | 1.7 | 1.21 | 0.83 |
| IMPORTED | | 0. | 0. | 0.2 | 2.8 | 4.7 | 6.5 | 7.2 | 5.5 | 3.47 |

* Annual official figures were first issued in 1854. The figures in the first column are a rough estimate only. Very small quantities, (e.g. less than 20,000 tons) are ignored.

# APPENDIX A

## VARIATIONS IN THE SOURCE OF SUPPLY OF IRON ORE

FROM 1750 onwards, smelting by coal or coke became general. The industry developed almost entirely upon the coal-fields and increasingly used ores of coal measure origin.

In the early nineteenth century nearly all the ore raised in this country was from the coal measures ;* there was almost no import and S. Wales, Staffordshire and Shropshire accounted for four-fifths of the total amount. The table opposite indicates the main changes which have taken place since 1850.

At this date the supply of ore from the coal-fields had reached its maximum and has steadily declined since. The reason for this decline lies in the fact that with improving transport facilities it was more economical for the iron-master to use an easily worked ore (i.e. one in which the mining costs were relatively low), even if this had to be brought some distance, than it was to use the coal measure ores, which from the very mode of their occurrence are usually expensive to work. But we must not under-estimate the importance of this source of supply even to as late a date as 1880. Upon it was based our world pre-eminence in the iron industry in the first two-thirds of the nineteenth century.

The decade, 1850-60, witnessed the rapid exploitation of new sources of supply. These may be grouped in three divisions :—

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* See *History of the Iron Trade*, by H. Scrivenor, 1854.

(1) *Ores of Jurassic origin.*—The outcrop of Jurassic rocks in England forms a great bow-shaped belt running through the Cleveland district, the Lincolnshire Heights, and then through parts of Leicester, Northamptonshire, Oxfordshire, Wiltshire and Gloucestershire.

Of this series the Lias is often and the Oolite sometimes (notably in the Northamptonshire sands) sufficiently ferruginous for working.

In this group the Cleveland mines (see p. 39) have up to the present been of the greatest importance, but the most accessible ores have been won and the last decade shows a distinct falling off.

The large-scale working of the Lincoln, Leicester, and Northants ore began a few years later. These ores are generally of very low grade and at some distance from the coal-fields. On the other hand they are in general the most easily worked in Great Britain, for unlike the Cleveland ore they are often worked in open quarries with steam shovels.

It has been their special function to displace the coal-measure ore at the more inland coal-field furnaces, e.g. in the Staffordshire, South Yorkshire, and Nottinghamshire furnaces.

Or again, furnaces working near the iron quarries supply pig iron to the older steel and foundry centres of the Midland coal-fields.

Together the Lincolnshire, Leicester and Northants production now exceeds that of Cleveland.

These same iron bearing Jurassic rocks are rendered accessible in the new Kent coal workings, and the proximity of coal, iron and the channel coast here may lead to an important industry.

(2) *Furness and Cumberland.*—The greatest production here was from 1870-90, when these high-grade non-phosphoric ores were in great demand in other iron districts for steel-making. The most accessible ore has been mined and the output has declined slowly since 1880.

(3) *Imported Ores.*—Mainly high-grade, easily worked and non-phosphoric. They are usually mined near the

coast of the country of origin (chiefly Spain, Algeria, Sweden), and are chiefly used by coastal plants in this country. In the last twenty years they have represented about one-third of the ore used in Britain and therefore (as high-grade ores) an even greater proportion of the pig-iron made.

# APPENDIX B

## STATEMENT SHEWING THE QUANTITY OF COAL RAISED DURING THE YEAR 1922

(In mills. of tons).

| | |
|---|---|
| ENGLAND AND WALES :— | |
| Northumberland | 13·2 |
| Durham | 34·9 |
| Cumberland and Westmoreland | 2·2 |
| Lancashire and Cheshire | 17·8 |
| Yorkshire, South | 27·7 |
| Yorkshire, West | 14·4 |
| Nottinghamshire | 12·6 |
| Derbyshire (except South Derbyshire) | 14·2 |
| Derbyshire, South | 1·0 |
| Staffordshire, North | 5·8 |
| Cannock Chase | 5·1 |
| S. Staffs and Worc. | 1·2 |
| Leicestershire | 2·9 |
| Warwickshire | 4·7 |
| Shropshire | 0·7 |
| Forest of Dean | 1·1 |
| Somerset | 0·8 |
| Bristol | 0·3 |
| Kent | 0·4 |
| South Wales and Mon. :— | |
| Anthracite | 4·5 |
| Other | 45·8 |
| North Wales | 2·7 |
| TOTAL | 214·2 |
| SCOTLAND :— | |
| Fife and Clackmannan | 8·3 |
| Lothians (Mid. & E.) | 4·3 |
| Lanarkshire, &c. | |
| Anthracite | 0·3 |
| Other | 18·2 |
| Ayrshire, Dumfries and Argyll | 4·3 |
| TOTAL | 35·4 |
| GREAT BRITAIN | 249·6 |

## COAL SHIPPED AS CARGO AND BUNKER FROM PRINCIPAL SHIPPING DISTRICTS IN 1922.

(In mills. of tons).

| | Export | | Coastwise | |
|---|---|---|---|---|
| | | Bunker | | Bunker |
| N.E. Coast | 22.6 | 3·3 | 6.9 | 0.26 |
| N.W. Coast | 0.8 | 2.9 | 2.2 | 0.51 |
| Humber | 5·9 | 3·0 | 0.8 | 0.07 |
| Bristol Channel | 25.6 | 4·5 | 2.2 | 0.21 |
| Scotland | 8.9 | 2.4 | 2.4 | 0.46 |
| U.K. (All ports) | 64.2 | 18.2 | 14.6 | 1.63 |

## TONNAGE OF COAL BROUGHT TO LONDON IN 1920.

(In mills. of tons).

| | | | |
|---|---|---|---|
| By Rail | ... | ... | 10.1 |
| By Sea | ... | ... | 7.8 |
| By Canal | ... | ... | 0.02 |

# EXPORTS OF COAL, COKE & MANUFACTURED FUEL FROM THE U.K. TO THE PRINCIPAL DESTINATIONS

## 1922

| *Destination.* | |
|---|---|
| *Europe and the Mediterranean.* | Thousands of tons |
| Russia | 584 |
| Sweden | 2523 |
| Norway | 1567 |
| Denmark (including Faroe Islands) | 2866 |
| Germany | 8346 |
| Netherlands | 6068 |
| Belgium | 3489 |
| France | 13579 |
| Portugal | 784 |
| Spain | 1711 |
| Italy | 6342 |
| Austria-Hungary | 3 |
| Greece | 429 |
| Algeria | 1032 |
| Channel Islands | 161 |
| Gibraltar | 689 |
| Malta | 214 |
| Egypt (including Anglo-Egyptian Sudan) | 1762 |
| Other European and Mediterranean Countries | 1408 |
| TOTAL | 53557 |
| *Africa and Asia.* | |
| Canary Islands | 525 |
| Azores and Madeira | 95 |
| French West Africa | 119 |
| Portugese West Africa | 194 |
| Aden and Dependencies | 93 |
| British India | 999 |
| Ceylon and Dependencies | 233 |
| Other Countries | 403 |
| TOTAL | 2661 |
| *South America.* | |
| Chile | 84 |
| Brazil | 1013 |
| Uruguay | 503 |
| Argentine Republic | 2021 |
| Other Countries | 70 |
| TOTAL | 3691 |
| North America and Central America | 4140* |
| Other Destinations | 149 |
| GRAND TOTAL | 64.198 |

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* American coal strike, 1922.

Statement shewing the Varieties and Quantities of Pig Iron made in each district of Great Britain from British and Foreign Iron Ores during the Year 1922, (in thousands of tons)

| District | Hematite | Ordinary |  | Basic | Direct castings and other qualities | Total made (including alloys) | Iron (included in prev. columns) sent in molten condition to steel works |
|---|---|---|---|---|---|---|---|
|  |  | Foundry | Forge |  |  |  |  |
| Derby, Leicester, Nottingham and Northampton .. | — | 445 | 115 | 58 | 80 | 698 | — |
| Parts of Lancashire and Yorkshire (including Sheffield) .. | — | 70 | 17 | 244 | — | 416 | 195 |
| Lincolnshire .. .. | — | 20 | 19 | 343 | 1 | 383 | 157 |
| North-East Coast .. | 609 | 269 | 63 | 454 | 2.6 | 14[illegible]5 | 324 |
| Scotland .. .. | 38 | 312 | 10 | 1 | — | 361 | — |
| Staffordshire, Shropshire, Worcester and Warwick .. | — | 42 | 50 | 295 | 7 | 394 | 135 |
| South Wales & Monmouthshire | 421 | — | — | 175 | — | 596 | 272 |
| West Coast .. .. | 504 | 7 | 3 | — | 1 | 560 | 41 |
| Total in 1922 .. | 1572 | 1165 | 277 | 1570 | 91·6 | 4903 | 1124 |